THE UNIVERSITY OF ALBERTA

THE RELATIONSHIP BETWEEN TRADE PRACTICE AND TRAINING PRACTICE IN MOTOR VEHICLE REPAIR

by

© ARNOLD BEZEAU

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The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies, a thesis entitled "The Relationship Between Trade Practice and Training Practice in Motor Vehicle Repair," submitted by Arnold Bezeau in partial fulfilment of the requirements for the degree of Master of Education.

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ABSTRACT

This study was conducted to determine three things; first, the nature of work activities in the motor vehicle repair trade in Alberta, second, the nature of instructional activities in motor vehicle repair trade training in Alberta, and third, the relationships between the above two determinations.

To obtain the necessary information, twenty selected automotive service operations were arranged in a paired comparisons configuration, and produced in questionnaire format. These questionnaires were mailed to a random sample of secondary automotive mechanics (N-300), an exhaustive sample of post-secondary automotive instructors (N-33), and an exhaustive sample of secondary automotive instructors (N=49), all within the province of Alberta. Scale values were computed for the twenty operations represented in the study, using a procedure consistent with Thurstone's Law of Comparative Judgement.

For several of the operations, the investigation revealed gross discrepancies between trade practice and trade training emphasis. In certain cases, extenuating circumstances justified these apparent trade-training misalignments, but in other cases, automotive instruction time seemed to be inappropriately portioned. The scale value for wheel alignment instructional time was 2.02 standard deviations above the

corresponding time reported by trade practitioners. Engine cylinder reboring was similarly rated 1.2 standard deviations higher in instructional time than in trade time. Conversely, the scale value for trade time directed to car accessory repair exceeded the scale value for corresponding instructional time by 1.5 standard deviations. In total, misalignments of more than one standard deviation between automobile repair trade practice and secondary automobile repair training times existed for seven operations; use a brake drum lathe, do wheel alignment, rebore engine cylinders, overhaul automatic transmission, adjust voltage regulator, repair car accessories, and replace carburetor/electrical component. Misalignments of more than one standard deviation between trade and post-secondary training times existed for six operations; do wheel alignment, rebore engine cylinders, replace clutch disc/ pressure plate, overhaul axle differential assembly, repair car accessories, and replace carburetor/electrical component.

A general conclusion was that these areas of automotive curricula require intensive study to determine the nature of the trade-training misalignments, and possible mitigating factors associated with them. Rethinking, and possibly revising of automotive curricula is required to ensure its relevance to the demands of the trade.

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CHAPTER I

ORIENTATION TO THE PROBLEM

1. INTRODUCTION

When the authors of the curriculum guide for a vocational course present, as stated objectives,

> to equip a student with sufficient skill and knowledge such that he will be highly employable in the . . . industry.

and,

> to enable the student entering the . . . apprenticeship program to advance at an accelerated rate on the basis of his proven ability on the job (Alberta Dept. of Education, 1966, p. 3).

then the interests of both the students and the patrons of the technical institute are served only if the course offerings are an accurate reflection of the graduates' prospective occupational requirements. If the curriculum is designed to meet the students' needs as they arise in and relate to specific trade employment, then an important source of information relative to these future needs must be the trade itself. Because technological and economic developments cause changes in trade practice and trade emphasis, vocational course content must reflect both a sensitiveness and a corresponding responsiveness to these changes.

With particular reference to the motor vehicle repair trade, three factors have tended to alter mechanics' occupational activities.

These three factors are:

a) The cost of labor has increased rapidly during the last decade.

b) The prices of replacement and rebuilt components and parts has tended to be stable relative to other automotive service costs.

c) Certain characteristics of modern automobiles make them "less repairable" with conventional human and physical resources, than was the case ten years ago (Edmonton Journal, 6/12/70, p. 47).

Consequences of these three factors might be, for example, that a mechanic's perspicacity as a diagnostician is more heavily taxed and his skill as a machinist and rebuilder is losing importance to his efficiency as a parts and components replacer. A typical automotive repair shop job may now involve diagnosis of the irregularity and replacement of the faulty component rather than the traditional and time consuming overhaul (including removal, disassembly, measurement, machining, reassembly and adjustment) of the original component. If this is true, then the relative emphasis among the skills and knowledges that mechanics are trained and tested over should continually evolve to maintain alignment with the current trade practice. Vocational courses with objectives as trade specific as the above cited ones must present content which is in close correspondence with the needs of the trade to be served.

II. STATEMENT OF THE PROBLEM

The purpose of this research was to compare automotive repair trade practice with the instructional content

of courses intended to supply the skilled workers for the trade. Answers to the following three questions were sought:

a) What were the constituents of automotive repair trade practice?

b) What were the constituents of vocational automotive course content?

c) What were the relationships between automotive trade practice and automotive course content?

Seeking answers to these three questions meant that practicing automobile mechanics had to be polled to ascertain the nature of their occupational activity, automotive teachers had to be contacted to inquire about the contents of their programs, and finally, these two determinations had to be compared.

Trade Investigation

An up-to-date description of the exact nature of the automotive occupation for which students are training should be available to the designers of automotive curricula. In order to accomplish this, a method was devised and put into operation which would generate current and objective accounts (and time profiles) of automotive repair trade activities so curriculum builders could have a more defensible basis for making course content decisions.

Vocational Training Investigation

This investigation was directed to both the secondary and the post-secondary levels of publically supported automotive repair trade training in Alberta. Distributions for time spent in training directed toward specific skills in

various service and repair operations were determined, to provide an answer to research question number two.

Comparisons

The two sets of data described above were compared to determine the degree of their congruence. This comparison, done both statistically and by a detailed examination of each operation, provided the answer to research question number three.

III. IMPORTANCE OF THE STUDY

This study was intended to measure the alignment of automotive courses to the automotive repair industry. An automotive training program which efficiently serves the needs of the trade is important from four points of view:

Importance of the Study for Students

A person training to enter the automotive repair trade in Alberta typically invests four years in an apprenticeship program, although part of this time may be substituted with either a thirty-five credit high school automotive course series (approximately 900 hours) or a two-year automotive service technology program. In any event, the expenditure of time, money, and effort on the part of the student is substantial, and from that individual's perspective, best value is realized if the training he receives is most useful in meeting his needs as they relate to his future employment in the automotive repair trade.

Importance of the Study for Employers

Provincial law requires that anyone engaged in the motor vehicle repair trade be either a licensed mechanic or an indentured apprentice (Government of Alberta, May 31, 1965). This restriction placed upon employers should be justified in terms of a high degree of competence possessed by qualified employees. The obvious extension of this situation is that the training required of a prospective practitioner in the motor vehicle repair trade should be relevant to the requirements for conversance in that trade.

Importance of the Study for Vocational Training Patrons

Individuals or organizations that support vocational training agencies by taxation, donation of equipment, donation of time and expertise, or by any other means must expect that their energies and resources so directed are in patronage of a cause that is in fact doing what it purports to do, at least within reasonable limits. This requires again that the efforts expended by vocational training agencies be aligned with the needs of the trade that is to be provided skilled workers.

Importance of the Study for the General Public

Because of the nature of the current technological culture, a large segment of society depends upon the motor vehicle, and the motor vehicle repair trade as a service industry. Well trained mechanics who can most expeditiously satisfy the motorists' needs are an asset in this regard.

IV. PARAMETERS OF THE STUDY

Populations from which data were obtained for the study reported here were all limited to the province of Alberta, and in fact, were all defined by Alberta Government legislation. The three groups polled were a stratified random sample of practicing journeyman automotive mechanics, an exhaustive sample of secondary school automotive teachers, and an exhaustive sample of post-secondary automotive instructors. There was no opportunity for automotive repair practitioners or instructors functioning outside Alberta to be represented in the samples generated for this study, so extrapolations to situations outside this province might be difficult to justify in terms of external validity.

The information supplied by the above described groups pertained to automotive repair operations represented in a questionnaire; this questionnaire was developed from twenty operations, and consisted of 190 matched pairs. Thus, the scale values produced were not exhaustive of activity in either the automotive repair trade or automotive repair training programs.

V. LIMITATIONS OF THE STUDY

Limitations of the study will be discussed under headings of Limitations Due to Populations and Limitations Due to Methodology.

Limitations Due to Populations

Exhaustive samples of teachers and instructors of

automotive courses established by the Alberta Department of Education were polled. This means that all levels of publicly supported automotive training were investigated, but that courses presented by the private sector (in-service training by automobile and automobile parts manufacturers for example) were not considered.

The population of participants in the automotive repair trade was as it appeared in the shop records maintained by the Apprenticeship and Tradesmen's Qualification Branch of the Alberta Department of Labor. However, administrative restrictions dictated that only the shop records maintained by the Edmonton office of the Apprenticeship Board be sampled. Geographically, this was the area of Alberta bounded by Fort McMurray on the north, Drayton Valley on the south, Lloydminster on the east and Jasper on the west. Demographically, about one-half of Alberta was represented, with offices in Grande Prairie, Calgary, and Lethbridge maintaining records for the remainder of the province. Interviews with Apprenticeship Field Supervisors at the time of the study provided indication that the trade as it existed in the above described area was typical of trade practice in the remainder of the province. Thus, it would seem not to be a violation of external validity to generalize from the sub-population available to the total provincial situation.

Limitations Due to Research Methodology

When comparing the relative frequencies with which mechanics do certain tasks to the proportions of time

automotive instructors devote to training in the same tasks, there are a large number of variables which must be accounted for before trade-to-training alignment can be defined as a one-to-one correspondence between the two sets of scale values. For example, certain complex but rather infrequently performed repair operations require a major instructional time commitment to develop a productive skill level in the trainee, but once acquired, this necessary skill may be practiced relatively infrequently. Another justifiable reason for lack of alignment between trade and training times may exist when the skills or knowledge required for a certain job are imparted concomitantly as training for another job progresses. A third possibility might be that a skill which is occupying an apparent disproportionately large amount of instructional time is actually serving as a vehicle to present instruction in other more relevant tasks. Further complicating the issue is the possibility that introductory (and heavily subscribed) courses may direct disproportionately large amounts of time to "basics" rather than "specifics." Therefore, as scale values were generated for times spent teaching toward certain skill developments, data from these programs would inordinately affect the results, because of the heavier statistical weighting they necessarily received.

It must also be acknowledged that the instrument used in this study represented only twenty operations, and as such, could not provide answers to questions regarding 'fine'

segments of the trade.

These limitations notwithstanding, the instrument and the way in which it was applied proved well suited to the demands of the study. Certain aspects of content and time distribution in automotive repair training curricula were shown to be inappropriate to the needs of the trade, and a number of other areas were opened to question.

VI. DEFINITIONS OF TERMS

For the purpose of this study, the following definitions apply:

> "Motor vehicle" means every vehicle propelled by any power other than muscular power except aircraft, traction engines powered by steam and such motor vehicles as run on rails or tracks.
>
> "Motor vehicle mechanic" means a person engaged in the repair or assembly of a motor vehicle and/or parts pertaining to the motor vehicle excepting the auto body as covered by the regulations governing the Trade of an Auto Body Mechanic and radio repair as covered by the regulations governing the trade of a Radio-technican.

The above two definitions were taken from the Tradesmen's Qualification Act as documented in the Alberta Gazette of May 31, 1965.

> "Practicing journeyman automobile mechanic" was defined as anyone whose name appeared so defined in the shop records maintained by the Apprenticeship and Tradesmen's Qualification Branch of the Alberta Department of Labor.
>
> "Automotive course" was defined as any curriculum which was either part of the province's automotive apprenticeship program, or articulated to the program with advanced standing. Such courses exist in Alberta at both the high school and post-high school level.

The names of the high school automotives teachers in

the province of Alberta (for the school year 1969-70) were available from the office of the High School Inspector of Industrial Education, so the population was thus defined. The Alberta Colleges Commission was able to provide the names of all automotives teachers serving in post-secondary institutions in the province, so again, this list provided the population definition.

VII. OVERVIEW OF METHODOLOGY

After reviewing the literature, and in consultation with Field Supervisors from the Apprenticeship Board, a list of twenty automotive repair operations was established. There was concensus from these two sources that each of the twenty operations was significant from a trade point of view, and consequential from a trade training point of view.

Using the model for the Law of Comparative Judgement* (Torgerson, 1958, pp. 159-204) each operation was paired with each other operation, giving a set of 190 pairs. This set of pairs was randomly ordered, and printed in the form of a questionnaire. Although members of all three samples (mechanics, secondary school teachers, and post-secondary

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*The Law of Comparative Judgement (or Thurstone's Matched Pairs) is a method of scaling psychological stimuli. Each stimulus is paired with each other one in the set, and the respondents are asked to choose, from each pair, the stimulus they perceive as greatest in the dimension being scaled (in this case, frequency of performance).

Consistent with a set of mathematical equations, each stimulus is assigned a scale value, of a magnitude determined by the portion of times it was chosen over each of the remaining stimuli.

automotive instructors) received the same questionnaire, it was accompanied by a different set of instructions for mechanics than for instructors and teachers. Mechanics were asked to indicate the operation in each pair that they personally had done most often in the past year, and to leave the item blank if they had not done either operation in the past year. Teachers and instructors were asked to mark the operation in each pair that they personally had spent the most time teaching toward in the past year, and similarly, to leave the item blank if they had not taught either of the two operations in the past year.

Questionnaires, instructions, covering letters, and stamped self-addressed envelopes were mailed to the sample members from the three populations. One follow-up letter was sent ten days after the initial mailing.

In analyzing the data, the conventional Paired Comparisons model was used, except that, for each sample, the number of people responding to each pair was recorded, and the frequency matrix was divided by this respondents' matrix to produce the proportion matrix. Ordinarily, the Paired Comparisions configuration is forced-choice, and each cell in the frequency matrix is divided by the number of people in the sample to produce the proportion matrix. However, the nature of this study required that a third "no to both operations" alternative be available to the respondent, and the above described computational modification permitted it without violating the Law of Comparative Judgement (Thurstone,

1959, p. 69).

Some check on the reliability of the obtained information was considered desirable. Of the three populations contributing information to the study, only the mechanics' was not sampled exhaustively, so a split halves comparison was used on this group. Sample members were identified by sequential numbering, with odd and even sub-samples thus identified. An indication of sampling reliability was obtained by correlating the two separate analyses of the data supplied by these sub-samples.

CHAPTER II

REVIEW OF RELATED LITERATURE

An investigation of the related literature suggests consideration under three headings; one dealing with the methodology of the trade analysis, one dealing with the content of the trade, and one dealing with the statistical technique applied to the obtained data.

I. LITERATURE RELEVANT TO METHOD OF ANALYSIS

If time profiles for various motor vehicle repair trade activities are to be compiled, there must be some method of systematically categorizing trade practices. Charles Allen, in his book The Instructor The Man and The Job introduced the concept of the block in the analysis of trade activities, and he noted that all jobs in a block call for the same kind of knowledge, skill, or use the same kind of tools or machines (Allen, 1919, p. 42). He described trade blocking as, "the first operation which the instructor must take in laying out a course of instruction" (Allen, p. 42). Still in the field of trade analyses and their implications for curricula, the blocking technique was considered by Fryklund in Analysis Technique for Instructors

> Some industrial occupations are made up of divisions of work each of which is practically an occupation in itself. That is, one can be trained in the division of the occupation and become a wage earner in it without knowing much about other divisions of that occupation.

> This applies to occupations in the service trades as well as to occupations in custom trades in mechanical work. These divisions are called blocks (Fryklund, 1965, p. 72).

To illustrate blocking in a service trade, Fryklund cites engine repair and maintenance, electrical repair and maintenance, and chassis repair and maintenance as components of the motor vehicle repair trade. In some trades, each block is coincidental with the machine being used. Identifiable blocks in the machinists trade for example would include ones associated with the lathe, the mill, and the shaper. Blocks in the motor vehicle repair trade, however, are associated, as Fryklund illustrated, with components or systems of the automobile. Numbers of specific activities can be identified within these blocks, and Fryklund called them operations.

Although the literature did not reveal a methodological account of an automotive repair trade analysis, three important pieces of research directed to other areas of study did come to light.

Ruben Snitz investigated the sheet metal workers' trade in 1931 and reported that

> In analyzing the sheet-metal workers' trade, as it is found in the charts, a list was made of all the various types of jobs that a sheet metal worker would have to do in order to become a skilled workman.

Having done this, Snitz further noted that

> . . . it became evident that certain groups of jobs called for the same kinds of skills, knowledges, tools, and materials. These were called units or blocks (Snitz, 1931, p. 57).

In 1966, A National Study of the Aviation Mechanics Occupation was compiled by Dr. David Allen and associates

from the University of California. This group of researchers divided the aviation airframe and power plant mechanics trade into blocks, and then identified, within these blocks, numbers of operations. For example, one block pertained to aircraft landing gear, and contained the following operations:

a) service and repair landing gear
b) inspect and replace tires and wheels
c) service and repair leveling devices
d) service and repair shock struts
e) service and repair nose wheel steering
f) service and repair brakes
g) jack aircraft and test gear
h) check alignment
i) service and repair anti-skid devices (Allen, 1966, p. 16).

J. A. Rinck (1968) used an analysis of almost identical format and content for his investigation of the needs of aircraft maintenance mechanics as they relate to content of secondary and post-secondary curricula.

There appears to be widespread acceptance of the use of blocks and operations in systematizing occupational practices within a trade for the purpose of analysis; this acceptance would recommend its application to the study reported here.

II. LITERATURE RELEVANT TO TRADE CONTENT

A library search for systematization of automotive repair trade practices returned four types of studies: textbooks, flat-rate manuals, curriculum guides, and trade analyses.

Automotive Textbooks

Textbooks for instruction in automotive courses are

often organized in blocks. William Crouse, author of Automotive Mechanics (5th Ed.) identifies twenty units of study and deals with each in a separate chapter or chapters as follows:

Engine Testing
Engine Service--Pistons and Connecting Rods
Engine Trouble-shooting
Engine Service--Crankshaft and Engine Block
Engine Service--Valves and Valve Mechanisms
Fuel System Service
Lubrication System Service
Cooling System Service
Electric System Service--The Starting System
Electric System Service--The Charging System
Electric System Service--The Ignition System
Clutch Service
Standard Transmission and Overdrive Service
Automatic Transmission Service
Drive Lines
Rear Axles and Differentials
Steering and Suspension Service
Brake Service
Tire and Tire Service
Air Conditioning (Crouse, 1965, pp. vi, vii).

Fryklund's definition of a block can be applied to the elements of the above list, by identifying commonalities in motor vehicle components or systems that each listed subject pertains to. With this ordering procedure, the following five areas are established:

Engine Service
Tune-up (fuel and electrical systems service)
Drive-line Service
Chassis Service
Accessory Service.

Each of the above listed units from Crouse is further sub-divided so each operation within an area is considered. The chapter on clutch service, for example, includes information under the following headings:

Clutch Trouble Shooting

Clutch Slips While Engaged
Clutch Chatters or Grabs When Engaging
Clutch Spins or Drags When Disengaged
Clutch Noises
Clutch Pedal Pulsations
Rapid Friction Disc Facing Wear
Clutch Pedal Stiff
Clutch Pedal Adjustment
Clutch Removal and Replacement
Clutch Overhaul
Inspecting and Servicing Clutch Parts

Other automotive mechanics textbooks have very similar content and organization (Tobolt and Purvis, 1965; Allen, 1960; Frazee and Bedell, 1965; Nash, 1961). Thus, the blocks and operations method of organizing trade content (for instruction in these cases) appears prevalent.

Flat Rate Manuals

A second type of publication using a modification of the blocks and operations organizational system is the flat-rate manual. Under the flat-rate system, every type of repair operation on all makes, models, and years of domestic and popular foreign-made cars (performed either singly or in combination with other operations) is assigned a flat-rate time, and this figure is used in calculating the customer's labor bill. In many cases, the flat-rate hour is also the unit of time according to which the mechanic is paid. Motor's Flat Rate and Parts Manual (Motor, 1970) is probably the most widely used and accepted source of operation times for flat-rate shops in North America.

Because of the intended use of the Motor text, and therefore the requirement for specificity, the major or primary divisions in this systematization are too narrow and

numerous to fit Fryklund's model. The headings noted below would indicate this specificity:

Maintenance
Exhaust and Emission Control
Tune-up and Ignition
Fuel System and Intake Manifold
Exhaust System
Starting Motor
Alternator and Generator
Dash Gauges, Speedometer, and Windshield Wipers
Battery Cables, Wiring Harnesses, and Horns
Lamps and Light Switches
Cooling System
Cylinder Head and Valves
Timing Case and Camshaft
Pistons, Rings, Bearings, and Crankshaft
Vibration Dampner, Flywheel, Engine Mounts
Engine Oiling
Clutch
Rear Suspension
Universal Joints and Rear Axle
Brakes
Front Suspension
Steering Linkage
Manual Steering Gear
Heater and Air Conditioning
Locks, Striker Plates, Regulators (Motor, 1970, pp. 4-46).

The secondary divisions or operations are consistent with Fryklund's description, but again, the requirement for specific detail results in each operation being listed separately for each make, model, and year of automobile. As a typical example, the operation CARBURETOR, R&R & OVERHAUL (that is, remove, overhaul and replace the carburetor) for Oldsmobiles from 1964 to 1970 is listed elven times to include the variations present in different years and models of this one make of car alone.

A much more general flat-rate schedule appears as a supplement to the Canadian Service Data Book (1968) which is produced yearly by the Maclean-Hunter Publishing Company.

In this case, trade practices are categorized into twelve sections, entered below:

Tires, Wheels, and Hubs
Brakes
Front Suspension and Steering
Engine--Mechanical
Engine--Cooling System
Engine--Tune-up and Electrical
Starting and Charging Systems
Manifolds, Engine Mounts, and Exhaust System
Clutch and Standard Transmission
Automatic Transmission
Driveline, Drive Axle and Suspension (Canadian Service Data Book, 1968, p. 191).

Each section is subdivided into a number of more specific operations (as was the case in the Motor publication) and each operation is assigned a general or average flat-rate time applicable to all makes of cars, unless an exception is noted.

Curriculum Guides

Curriculum guides for secondary and post-secondary automotive courses represent a third type of literature which was studied to reveal organizational patterns, and for this purpose, the Alberta Department of Education Senior High School Curriculum Guide for Automotives 12-22-32 (1966) and the Provincial Apprenticeship Board Detailed Course Outline for Motor Mechanic Apprentices (1968) were reviewed.

According to the high school Automotives 12-22-32 curriculum guide, a student completing the three-course series will have spent in excess of 900 hours studying the automotive trade under the following headings:

Introduction and Basic Tools
Orientation

Shop Safety
Trade Information
Guidance Information
Business Organization

Chassis
Lubrication and Servicing
The Internal Combustion Engine
The Fuel System
Hydraulic Brake System
Clutch
Transmissions
Drive Line
Rear Axle Assembly
Front End
Steering and Wheel Alignment
Ignition System
Wheels and Tires
Lubrication System
Cooling System
Electrical System

The first six headings (drawn from each of the three courses) were set apart because they pertain to background and related information rather than actual trade skills. Most of the remaining units are to be superficially covered at the grade ten level (Automotives 12) and subsequently treated in more depth during the grade eleven and twelve years (Automotives 22 and 32). In any event, it is important to note the similarities in the organizational nature of this scheme compared with the format of automotive textbooks, and also the extent to which the organization fits Fryklund's model.

As part of an Alberta mechanic's four year apprenticeship, he spends eight weeks during each year of his program studying at one of the province's technical institutes. The Detailed Course Outline for Motor Mechanic Apprentices (1968) contains the course content recommendations for these thirty-two weeks of instruction which total 960 hours:

SUBJECT	HOURS/WEEK	HOURS/YEAR	TOTAL
Shop Work	15	120	480
Theory	10	80	320
Mathematics	2	16	64
Science	2	16	64
Business Knowledge	1	8	32
Total	30	240	960

Considering only the shop work and theory subject, that is, the instruction aimed directly at trade material and accounting for 5/6 of the total time, units of study have been established as outlined in the following chart:

Basic Hand Skills	1
Manual Transmissions and Drive Lines	1 & 2
Differential and Rear Axle	1 & 2
Steering and Suspension	1 & 2
Braking Systems	1 & 2
Friction Clutches	1 & 2
Engines	1 & 2
Cooling Systems	1 & 2
Fuel Systems	1 & 2
Electrical Systems	3
Power Accessories and Equipment	3
Automatic Transmissions	4

Note: The numbers following each unit indicate the year(s) of study (1 to 4) during which the topic is covered. Most of the material is introduced during year one and treated in detail at a later time.

Trade Analyses

With reference to actual analyses conducted in the automotive repair trade, the Department of Labor of the Government of Canada, in 1957, produced An Analysis of the Motor Vehicle Repair Trade in which they listed twenty-seven headings under five major divisions of activities within the mechanics' trade (Dept. of Labor, 1957).

MISCELLANEOUS PROCEDURES

Block 1 General Shop Practice
2 Running Gear
3 Brakes: Hydraulic, Vacuum, Air
4 Lubrication
5 Clutches
6 Transmissions
7 Universal Joints
8 Propeller Shafts
9 Differentials
10 Rear Axles

FUEL AND EXHAUST SYSTEMS

Block 11 Basic Science Related to Carburetion
12 Carburetors
13 Fuel and Vacuum Pumps
14 Components of the Carburetion System

ELECTRICAL SYSTEMS

Block 15 Basic Science
16 Battery
17 Generator
18 Charging Circuits
19 Ignition
20 Starters
21 Lighting
22 Accessories
23 Gauge Circuits
24 Motor Tune-up
25 Power Actuated Units

ENGINES: ACCESSORIES AND COMPONENTS

Block 26 Cooling System
27 Maintenance Techniques

Blocks 1, 11, and 15 describe knowledges and skills which are used by mechanics as they function in their trade generally. The remaining twenty-four blocks describe specific service operations relating to the given component

or system upon which the block is based.

The authors of textbooks, flat-rate manuals, curriculum guides, and trade analyses use quite similar techniques in organizing and categorizing automotive trade practice. However, their degree of specificity and detail shows some variability, accounted for by the differences in intended purpose of the particular document. In any event, the practice of establishing blocks according to components such as the electrical and braking systems appears to be a widely accepted basis for organization.

III. LITERATURE RELEVANT TO STATISTICAL ANALYSIS

The problem of establishing profiles to represent the time loadings for service operations within the motor vehicle repair trade is amenable to scaling techniques, specifically a method known as paired comparisons. This measurement procedure is executed by matching every stimulus (in this case every trade operation) with every other one, that is, generating all possible pairs, and having the subject respond to them in ordinal fashion, indicating which of the two stimuli is greater, or in possession of more of the particular attribute being scaled. According to the Law of Comparative Judgement, the paired comparisons technique is applicable to studies involving replication over trials within a single judge (Class I), replication over judges within single trials (Class II), and replication over both judges and trials (Class III) (Torgerson, 1958, p. 207). This study used the Class II

model.

According to Thurstone

> Suppose that 50 percent of the judges say that crime A is worse that crime B, and that the remaining 10 percent vote that B is the more serious. Now, suppose further that 55 percent, barely more than half the judges, say that crime B is more serious than crime C. Then we should be justified in saying that the separation between the two offenses A and B on a scale of seriousness is much greater than the separation between B and C on that same scale (Thurstone, 1959, p. 68).

The returns from the judes are arranged in an F matrix of dimension n x n (where n = no. of stimuli) so that each cell indicates the number of times stimulus j (column) was selected over stimulus i (row). Next, the F matrix is used to generate a P matrix which indicates the proportion of times each stimulus is judged greater than each other one. Finally, the X matrix is formed by expressing the P values as unit normal deviates. By averaging the columns of the X matrix, scale values in raw score form are obtained, and these are normalized to mean = 0 and standard deviation = 1. If the data collected from the research yield any incomplete matrices, the "Traditional Condition C Solution" is used to estimate scale values (Torgerson, 1958, p. 175).

When considering the possible alternatives to the statistical technique of paired comparisons or "Thurstone's Matched Pairs," Comrey's model for fractionation appears relevant, but Torgerson's comments discourage its use.

> Both the subjective estimate and the fractionation methods present rather formidable tasks to the subject. In one instance, he must be able to report directly the scale value of the stimulus, under some circumstances even selecting his own unit and origin, whereas, in the

> other, he must be able to report directly the scale value of the sense ratio between pairs of stimuli. It is difficult to conceive how a subject could make these responses unless he had directly available to him, with all of its properties, a 'ruler' of the attribute to be scaled. Indeed, we could consider these two scaling procedures to me merely practical ways of asking the subject to reproduce his ruler for us (Torgerson, 1958, p. 117).

CHAPTER III

METHODOLOGY

I. INTRODUCTION

The study reported here involved developing a questionnaire, generating samples from four populations, administering the questionnaire, and analyzing the data. Each of these four facets of methodology will be discussed under a separate heading.

II. THE QUESTIONNAIRE

It was necessary to develop an instrument for this study, because a standardized or previously developed instrument was not available. This meant that decisions had to be made regarding the contents of the survey instrument to be used, and also the form it would take. These decisions will be discussed under separate headings.

Contents of the Questionnaire

The selection of automotive repair operations for inclusion in the questionnaire was done according to two criteria. The first criterion considered was that the operations must be as comprehensive (and as representative) as possible of trade activity. Second, they should be as significant as possible to automotive repair trade training. Additionally, they should not be so numerous as to make the

questionnaire excessively long. After referring to the literature, and in consultation with personnel from the Apprenticeship Board, twenty operations were selected from a list which originally numbered thirty. These twenty operations, considered to best meet the above three criteria, may be seen in Table I, List of Automotive Repair Operations Included in Questionnaire, p. 28.

Type of Questionnaire

The scaling technique called matched pairs or comparative judgement was chosen for use in the study reported here. This decision was based on the nature of the technique, and Torgerson's comments about it (Torgerson, 1958, pp. 159-204). According to the Law of Comparative Judgement, each stimulus (in the case of this study, each operation in the questionnaire) in turn serves as the standard against whcih each remaining stimulus is judged. Therefore, the subject need respond to each pair in ordinal fashion only, by choosing the stimulus in each pair that is greater on the dimension being scaled. It is the data from replication over judges, and the computational procedures involved in the Law of Comparative Judgement, which enable the ordinal discriminations for each stimulus to be expressed as scale values rather than simply as ranks.

For questionnaires of the above described type, in paired comparison configuration, if n equals the number of operations, then the number of pairs is equal to $\frac{n(n-1)}{2}$. All possible pairs of these twenty previously selected

TABLE I

LIST OF AUTOMOTIVE REPAIR OPERATIONS

INCLUDED IN QUESTIONNAIRE

1.	Use a Brake Drum Lathe
2.	Overhaul Brake Cylinders
3.	Replace Steering/Suspension Parts
4.	Do Wheel Alignment
5.	Use a Valve Grinder/Valve Seat Refacer
6.	Replace Piston Rings
7.	Rebore Engine Cylinders
8.	Fit Piston Pins
9.	Replace Crankshaft Bearings
10.	Replace Clutch Disc/Pressure Plate
11.	Overhaul Standard Transmission
12.	Overhaul Automatic Transmission
13.	Overhaul Axle Differential Assembly
14.	Overhaul Electrical Component
15.	Overhaul Carburetor
16.	Adjust Voltage Regulator
17.	Replace Standard/Automatic Transmission
18.	Repair Car Accessories
19.	Do Minor Tune-up
20.	Replace Carburetor/Electrical Component

operations were generated (numbering 190 in all) and randomly ordered to produce the text of the questionnaire. This was done by using the APL facilities of the IBM 360/67 computer. The same questionnaire form was sent to all members of each of the four samples, but the covering letter and the instructions for completing the questionnaire differed for each group. These differences are discussed under the heading Administering the Questionnaire. Appendix A, p. 71 contains a copy of the questionnaire.

III. THE POPULATIONS AND SAMPLES

The study sought to elicit information from four distinctly defined populations: mechanics, secondary school automotive teachers, post-secondary school automotive instructors, and apprenticeship field supervisors.

Mechanics

The population of certified and practicing motor vehicle repairmen was defined, for the purposes of this study, as it was documented in the shop records maintained by the Apprenticeship and Tradesmen's Qualification Branch of the Alberta Department of Labor. Adminstrative restraints dictated that only the records housed in the Edmonton office of the Apprenticeship Board be used. However, Apprenticeship Field Supervisors stated that these records were an accurate reflection of the provincial circumstance. On the basis of this statement, extrapolation to the total Alberta scene seemed justifiable.

In consideration of expenditures of time and money, and with a view to the effects of sample size on standard error or statistical confidence limits as discussed in Foundations of Behavioral Research (Kerlinger, 1964, p. 61), it was decided to poll a sample of 300 mechanics. This sample represented 11% of the approximately 2700 practicing mechanics in the Edmonton area (and 5.5% of the approximately 5500 practicing mechanics in Alberta) at the time of the investigation. Approximately two-thirds of the records held by the local office of the Apprenticeship Board pertained to mechanics in Edmonton employment situations, and the remaining one-third to employment situations in smaller municipalities outside urban Edmonton. The sample was stratified in this proportion and the individual selections were made according to randomly generated numbers.

Secondary School Automotive Teachers

The office of the Provincial High School Inspector of Industrial Education has, each year, produced a list of secondary school Industrial Education teachers in Alberta. The 1969-70 list, current at the time of this investigation, contained the names of forty-nine full-time automotive teachers. This population was exhaustively sampled.

Post-Secondary Automotive Instructors

A list of all post-secondary automotive instructors was obtained from the Alberta Colleges Commission, and this population of thirty-three instructors was exhaustively

sampled.

Apprenticeship Field Supervisors

The position of Field Supervisor in the Apprenticeship and Tradesmen's Qualification Branch imposes two sorts of responsibilities on the incumbent. First, he must periodically visit shops where mechanical work is done, to check that the individuals doing the work are either certified mechanics, or indentured apprentices. Second, he must visit each shop where an indentured apprentice works, for the purpose of checking the apprentice's progress. Also, he must see that the employer is providing the apprentice with work experience of a nature that contributes to the development of his mechanical skills. Field Supervisors are required to have prefaced their appointment to this position with certification and experience in the trade they supervise. The point is that the individuals acting as Field Supervisors to the Motor Vehicle Repair Trade are knowledgeable in the trade, and are, as a matter of job routine, observing mechanics working in a large number of repair shops. Therefore, these people, viewing the trade from a broad perspective, were able to provide information of value to this study.

Automotive Apprenticeship Field Supervisors from Edmonton and Calgary were experimentally accessible, and this group, numbering four, was exhaustively sampled.

IV. ADMINISTERING THE QUESTIONNAIRE

The questionnaire for this study was administered to a pilot group first, and then to the members of the four samples drawn for the main study. Analysis of the data supplied by participants in the pilot study indicated that the instructions, the questionnaire, and the analysis program were all functioning as planned, and therefore no changes were considered necessary before the main study was started.

The questionnaire, prefaced by instructions and accompanied by a covering letter and a stamped self-addressed envelope was mailed to each mechanic, teacher, and instructor in the samples. Teachers' home addresses were available and used but in the cases of mechanics and post-secondary instructors, the letter and questionnaire were addressed to their places of business, since home addresses were not available. Each covering letter was individually typed on an IBM MT/ST to avoid the "form letter" appearance, in an attempt to thereby encourage co-operation from the sample members. The mechanics' covering letters asked them to respond to the questionnaire according to their own personal trade activities. Appendix B, p. 77, contains copies of the covering letter and the instruction sheet that was sent to members of the mechanics' sample. The instructors' covering letters asked them to supply information about their own personal teaching activities. Appendix C, p. 80, contains the same material, in the form that was sent to secondary

and post-secondary automotive instructors. The initial mailing was followed in ten days by reminder letters sent to those sample members whose completed questionnaires had not been returned.

Apprenticeship Field Supervisors were contacted personally at their places of business, both to deliver their questionnaires and to pick up the returns. A covering letter was therefore unnecessary, and in this case the instructions for completing the questionnaire were of the same form as for mechanics (illustrated in Appendix B), except they were prefaced by an addendum which is shown in Appendix D, p. 83. This addendum requested that information be given not on the basis of personal trade activity, but rather on the basis of the Field Supervisor's observations of total trade activity.

V. ANALYZING THE DATA

The Thurstone's Matched Pairs measurement technique used in this study required that the respondent provide an ordinal judgement on every stimulus relative to every other one. All possible pairs of stimuli were generated and presented to the sample members, in this case via a questionnaire format (Appendix A, p. 71). According to Torgerson, "Each time the two stimuli are presented to the observer, he is required to judge which is higher on the psychological continuum (eg. which is louder, heavier, or more beautiful)" (Torgerson, 1958, p. 160). In the study

reported here, the stimuli were automotive repair and maintenance operations, and the continuum on which they were to be placed was frequency of performance.

Thurstone's model for comparative judgement (Torgerson, 1958) was modified by the investigator in one respect before it was applied to the data obtained in this study. Conventionally, each cell in the F matrix is divided by the number of respondents in the sample, to produce the P matrix. Because the Thurstone model is a forced choice situation, every member of the sample selects a stimuli from each pair presented to him, so the number of respondents to each pair is the same; that is, the number in the sample. However, it certainly was the case in this study that some mechanics and instructors did neither of the two operations in some pairs, so the forced choice configuration had to be revised to permit a respondent the option of not providing information about the relative frequency with which he did certain operations. This meant, that since the frequency of performance could be zero for each of the operations in some pairs, the subject must have this possible response available to him, and the revision to the model accepted this alternative as missing data. Further, although the questionnaire instructions did not mention this possibility, some respondents perceived the frequency with which they did certain sets of tasks as equal, and therefore marked both operations in some pairs. Again, this represented "no information" regarding which of the two operations was in

fact performed most often, and the revised Comparative Judgement model in each case accepted this response as a missing datum situation. For computational purposes, it was therefore necessary to establish an additional "Number of Respondents" matrix in order to record the numbers of subjects that supplied information pertaining to each paired comparison. The P matrix could then be developed by dividing the contents of each cell in the F matrix by the contents of the corresponding cell in the "Number of Respondents" matrix. At this point, the Thurstone model, without further alteration, was used to generate the X matrix and the scale values. Incomplete matrices were treated according to Condition C (Torgerson, 1958, p. 170).

A Fortran IV program was written to conduct the above described scaling procedure, and the information from the returned questionnaires was key-punched onto IBM 5081 data cards for processing.

Inter-judge correlation, as a measure of reliability, was not applicable to this study because respondents (with the exception of Apprenticeship Field Supervisors) were asked to describe their own particular circumstance, and not to estimate the global state of nature within the trade or profession. Therefore, inter-judge correlations would be related to the homogeneity (or lack of it) in the sampled population, and would not necessarily be a measure of reliability. The sample of mechanics was split (odd and even) into two halves, and separate scales generated and

compared. This split halves correlation was considered a measure of the reliability of the mechancis responses (Thorndike and Hagen, 1969, pp. 177-199).

The populations of automotive instructors (secondary and post-secondary) were sampled exhaustively. A split halves reliability check was therefore considered unnecessary, since the representativeness of the sample to the population could not be questioned.

Comparisons between sets of scale values took three forms. First, for a mathematical comparison, a correlation matrix was calculated, using the Pearson's r formula (Ferguson, 1966, p. 111). Second, because scale values could not be computed from the data supplied by the Apprenticeship Field Supervisors (insufficient data due to small sample size) the operations were ranked accoring to proportion averages, and a second correlation matrix was computed using the Spearman rank order model (Ferguson, 1966, p. 217). Third, detailed considerations of the scale values from different groups for each operation were conducted. This permitted apparent gross misalignments (greater than one standard deviation) between trade and training to be examined in light of the four factors mentioned as limitations of the study.

CHAPTER IV

PRESENTATION OF THE FINDINGS

I. INTRODUCTION

Three rather separate investigations were required to obtain answers to the questions which prompted this study. First, the nature of the automotive mechanics occupation had to be determined, second, there had to be a measure of the sorts of training automotive students are exposed to, and finally, there had to be a comparison of the above two assessments.

The required trade practice and trade training information was elicited using an instrument developed especially for this study. Stage one of this development involved choosing automotive repair operations on the basis of significance to the trade and consequence to trade training. Twenty operations were identified according to these criteria, and were set out in paired comparisons configuration, to form the body of a questionnaire. The data obtained by this questionnaire were analyzed according to a modification of Thurstone's model for Comparative Judgement, to produce scale values for the relative frequency with which the twenty operations were performed. In all cases, the frequency scale values were standardized to mean=0 and standard deviation=1.

Details of the automotive repair trade survey, the

automotive repair trade training survey, and the comparison of the results of these two assessments are presented under subsequent headings.

II. RESULTS OF AUTOMOTIVE REPAIR TRADE SURVEY

To determine the distribution of time spent performing various operations in the automotive repair trade, and to reach this determination with some knowledge of its reliability, four steps were involved. First, the questionnaire was given to a pilot group of fifteen mechanics, and their responses were analyzed. This analysis suggested that no changes were required in the questionnaire or its accompanying instructions, so these results were tabulated and steps were taken to proceed with the main study.

To this end, each of the three hundred randomly selected mechanics in the main sample was mailed an envelope containing the questionnaire, instructions for completing the questionnaire, a covering letter, and a stamped self-addressed envelope. The completed and returned questionnaires numbered 238 (79.3 percent of the total). The data they contained were analyzed and used to produce the scale values plotted in Figure 1, p. 39. This graph indicates that reboring engine cylinders and fitting piston pins (both operations requiring considerable machining time) were done relatively infrequently (2.5 and 1.6 standard deviations below the mean respectively). On the other hand, service operations such as minor tune-ups and car accessory repairs

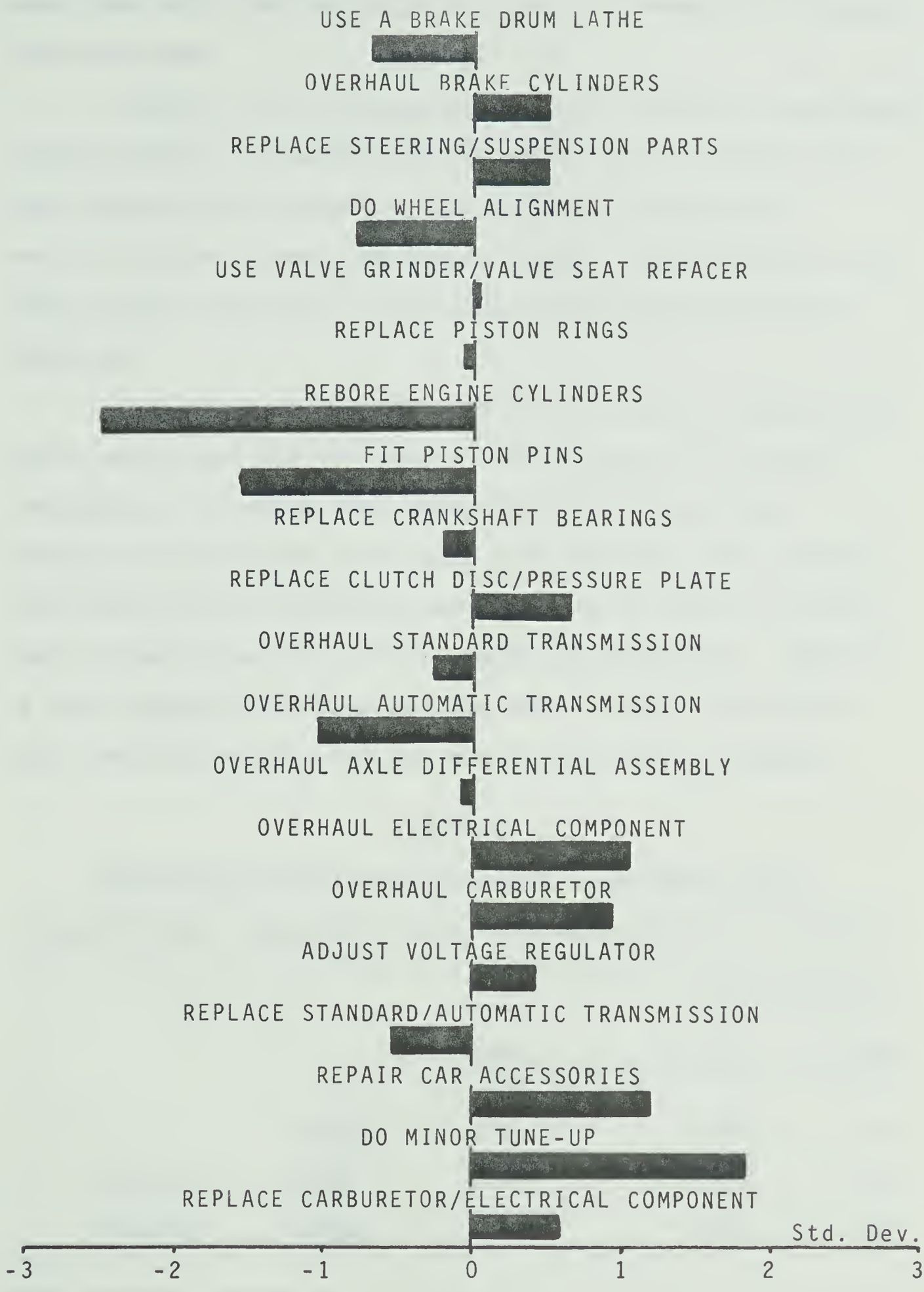

FIGURE 1

FREQUENCY WITH WHICH MECHANICS PERFORM SELECTED OPERATIONS

were done with frequencies of 1.9 and 1.2 standard deviations above the mean.

Eight of the questionnaires were returned uncompleted, either because the sample member could not be located with that address, or because he was no longer active as a mechanic in the automotive repair trade. Appendix E, p. 85 contains the matrices of respondents and proportions for mechanics.

The third step in the automotive repair trade survey was to split the 238 returned questionnaires into halves (according to whether they were numbered odd or even), analyze the data from each half, and correlate the results. This split-halves technique was employed to gain an indication of the reliability of the sampling procedure. Table II is the correlation matrix for the total sample, the split-half even sub-sample, and the split-half odd sub-sample.

TABLE II

CORRELATION MATRIX OF MECHANICS' FREQUENCY SCALE VALUES-TOTAL, SPLIT-HALF EVEN, AND SPLIT-HALF ODD SAMPLES

			SPLIT HALVES	
		TOTAL	ODD	EVEN
	TOTAL	1.00	0.98	1.00
SPLIT	ODD	0.98	1.00	0.98
HALVES	EVEN	1.00	0.98	1.00

The correlation coefficient for the scale values from the two sub-samples was 0.98. This figure indicated a very strong positive relationship between these two groups, and therefore served as a favorable endorsement for the reliability of the sampling procedure in representing the population.

Finally, as an additional measure of reliability, the Field Supervisors from the Edmonton and Calgary offices of the Tradesmen's Qualification and Apprenticeship Board were polled for their perception of the frequency with which trade operations were performed. For this purpose, the same questionnaire was used as for mechanics, except that the instruction sheet was prefaced by an addendum, which is illustrated in Appendix D. The relationship between their returns and the corresponding information supplied by mechanics was noted. Analysis of this group's data revealed that each of the four Field Supervisors indicated engine reboring was done less often than any other operation, so column seven in the X matrix for this group contained only empty cells, and therefore data was insufficient to compute scale values. In the absence of interval data, the Spearman's rank order model was used to compare proportion averages, and the figure of 0.78 was found to be the measure of the ordinal relationship between frequencies of tasks performed as perceived by Field Supervisors and as reported by mechanics. A correlation coefficient of this magnitude was supportive of the data obtained from the larger sample of mechanics.

III. RESULTS OF AUTOMOTIVE REPAIR TRADE TRAINING SURVEY

Publicly supported automotive repair trade training in Alberta can be dichotomized, and consideration directed to secondary and to post-secondary levels. In this study, the populations of instructors at each of these two levels were exhaustively sampled. Their reports of the amounts of time they spent teaching toward skill in each of the twenty operations included in the questionnaire are presented in Figures 2 and 3, pp. 42,44. Seventy-eight percent (26 of 33) of the post-secondary instructors and 61 percent (30 of 49) of the secondary instructors completed and returned their questionnaires. Appendices F and G contain the matrices for respondents and proportions from secondary and post-secondary instructors.

IV. COMPARISON OF TRADE TRAINING AND TRADE ACTIVITY

For certain automotive repair operations, large discrepancies existed among the scale values generated from the three sources of data. A description of the magnitude of these discrepancies is given by the correlation matrix in Table III, p. 45. The correlation of 0.57 for mechanics' scale values and secondary teachers' scale values is significant at the .01 level, the correlation of 0.30 for mechanics' scale values and post-secondary teachers' is not (Fisher and Yates, 1963).

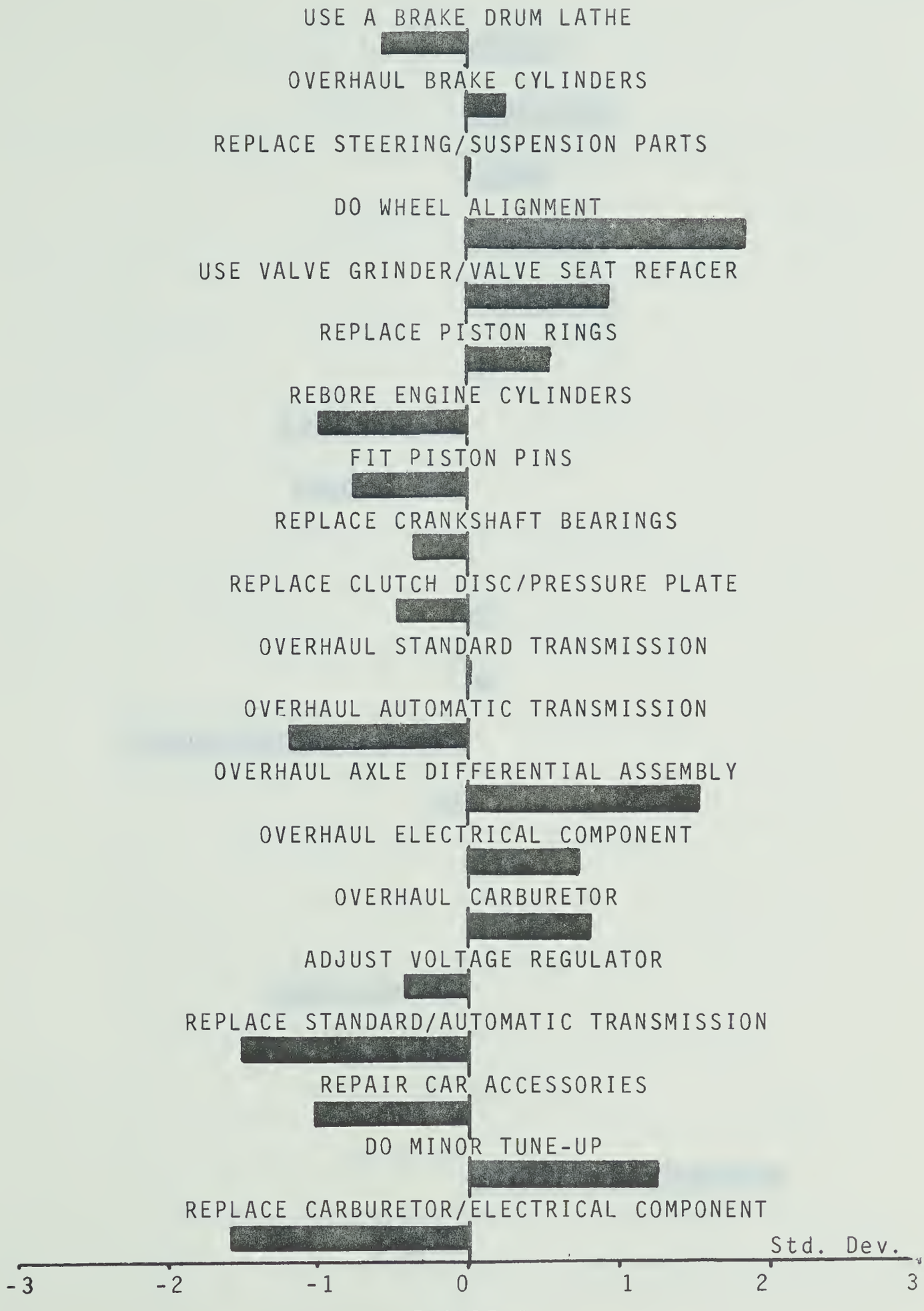

FIGURE 2

POST-SECONDARY AUTOMOTIVE INSTRUCTION TIME DISTRIBUTION

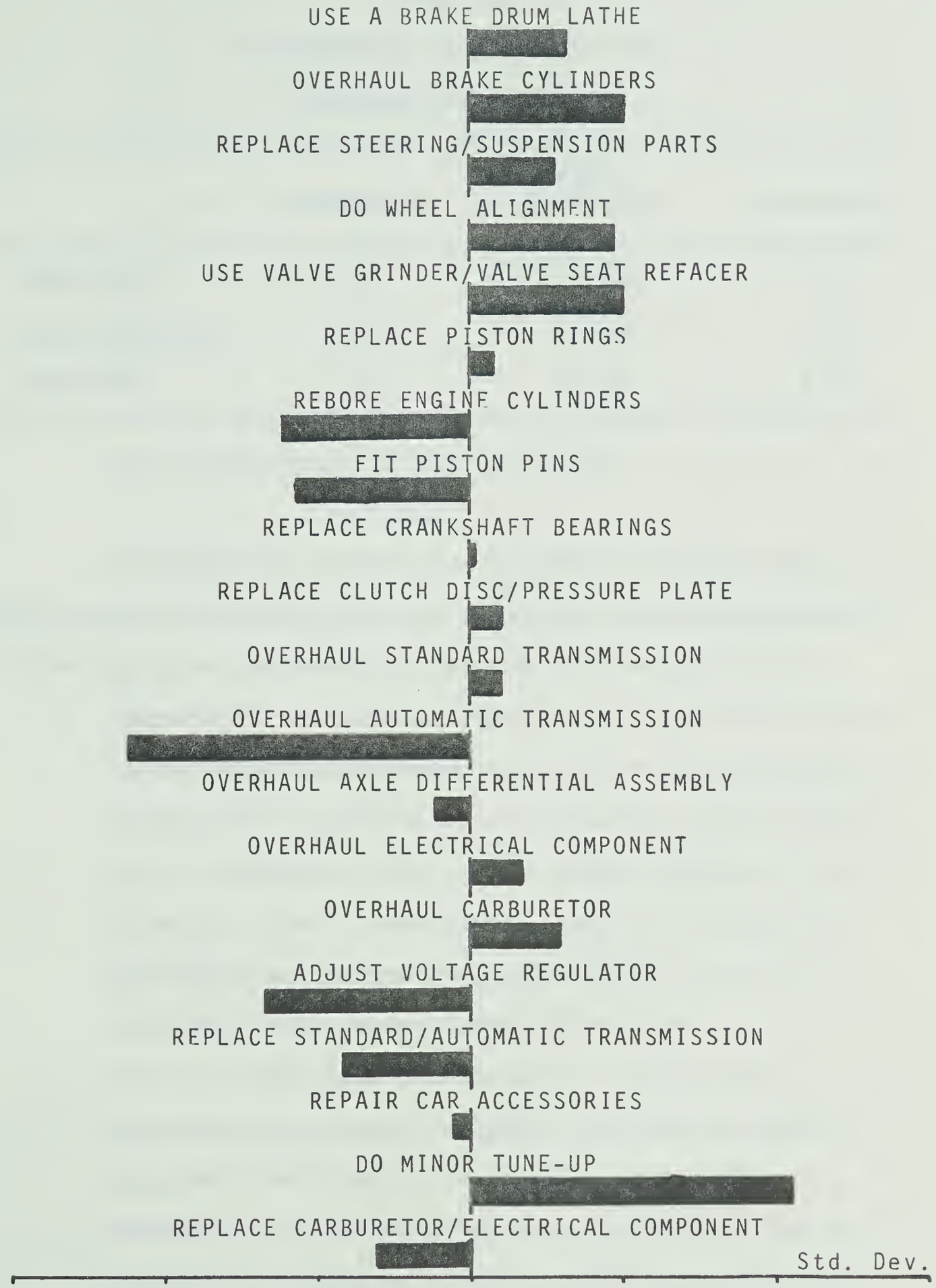

FIGURE 3

SECONDARY AUTOMOTIVE INSTRUCTION TIME DISTRIBUTION

TABLE III

CORRELATION MATRIX TRADE AND

TRAINING SCALE VALUES

	MECHANICS	POST-SECONDARY	SECONDARY
MECHANICS	1.00	0.30*	0.57
POST-SECONDARY	0.30*	1.00	0.68
SECONDARY	0.57	0.68	1.00

*Not significant at the .01 level.

It should be remembered, however, that the ideal relationship between trade and training is not necessarily a one-to-one correspondence, for the following reasons:

1. Competence in certain infrequently performed operations (especially those concerned with automobile safety) may be required of mechanics, and training to the necessary skill level could require a considerable time. Conversely, skill in frequently performed but perfunctory operations could be imparted with a short instruction time.
2. Skill in some activities may be concomitantly acquired as a student mechanic engages in study directed toward skill in another area. This phenomenon is called transfer of training, and is difficult to measure (DeCecco, 1968, pp. 439-443). It may be suggested, for example, that the electrical

knowledge required to intelligently diagnose and remedy a malfunction in a charging system is also applicable to service problems associated with other automotive electrical systems such as the starting, ignition, or electrical systems.

3. Certain automotive shop training activities may be useful as vehicles for presentation of other associated skills. For example, although engine reboring appears from the survey to be of minor relevance to the automotive repair trade, it is an operation which typically includes most of the more frequently used engine repair skills such as those required for piston ring replacement, and crankshaft bearing replacement, and it could be argued that its inclusion in the curriculum is justified on this basis.
4. Considering the attrition rate in automotive courses, it might be the case that skills taught early in a multi-year automotive training program appear to be receiving more instruction time when in fact this appearance is due to the large number of students to whom instruction is directed at that level.

It seems to follow, therefore, that the information obtained by means of the comparative judgement questionnaire should not be used to make critical comparisons between trade and training times unless the operation in question has a gross time misalignment between the scale values from the two sources of data.

In light of the four previously mentioned points, each of the twenty operations represented in the questionnaire is dealt with separately, and the relationships between the three scale values deviate from the trade scale value by more than one standard deviation, the nature and possible justifications for this apparent misalignment is discussed.

Use a Brake Drum Lathe

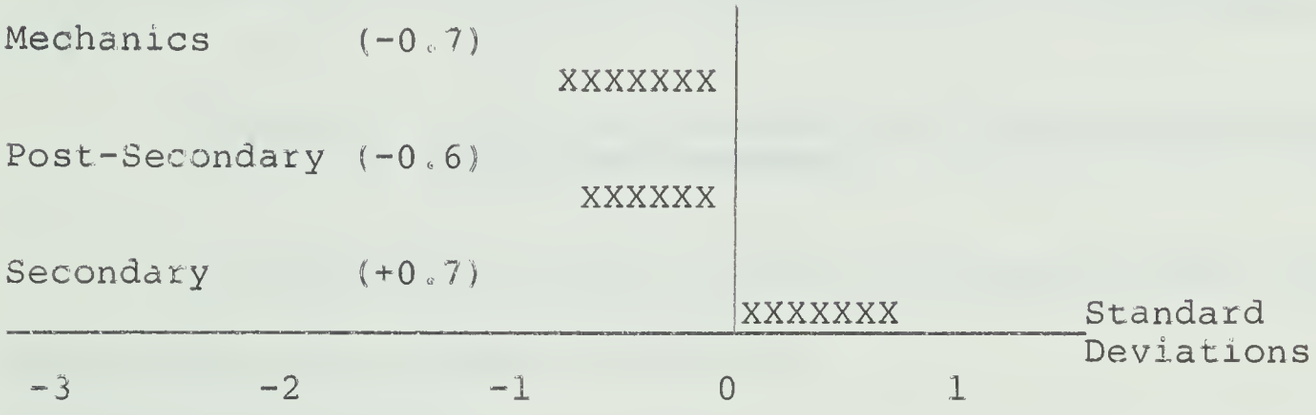

Figure 4: Relative Frequency of Brake Drum Lathe Use.

Although this operation received comparable scale values from the mechanics' sample and from the post-secondary automotive instructors, secondary school teachers reported a frequency scale value which was 1.3 standard deviations greater than the corresponding figure reported by mechanics.

Overhaul Brake Cylinders

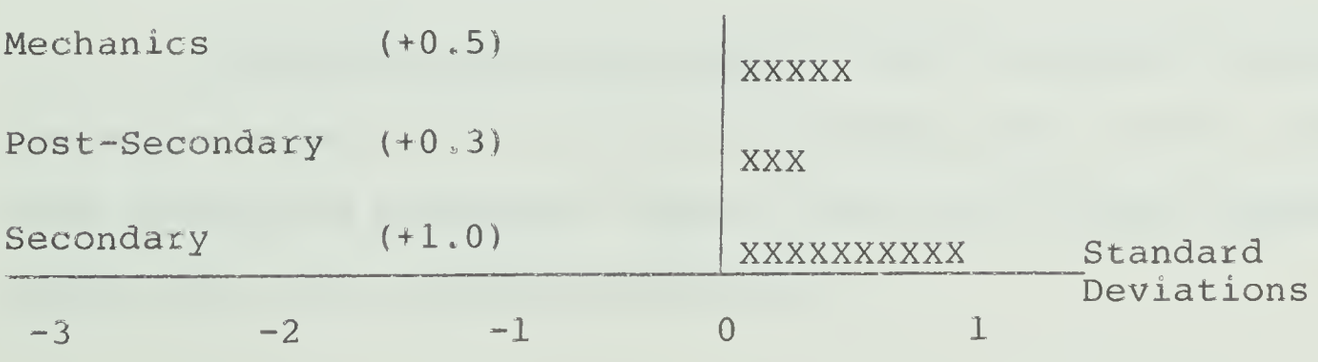

Figure 5: Relative Frequency of Brake Cylinder Overhaul.

Discrepancies between trade and training scale values were within one standard deviation.

Replace Steering/Suspension Parts

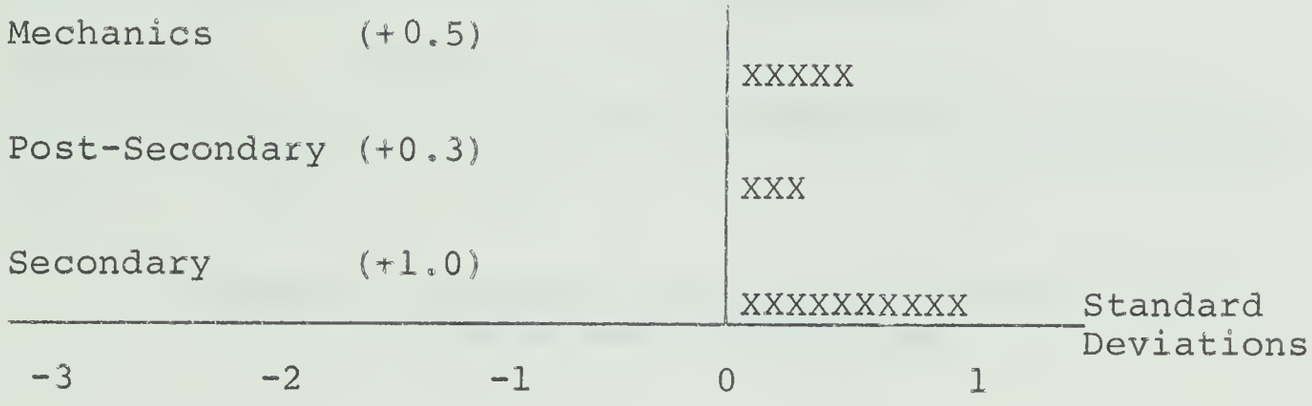

Figure 6: Relative Frequency of Steering/Suspension Parts Replacement.

Discrepancies between trade and training scale values were within one standard deviation.

Do Wheel Alignment

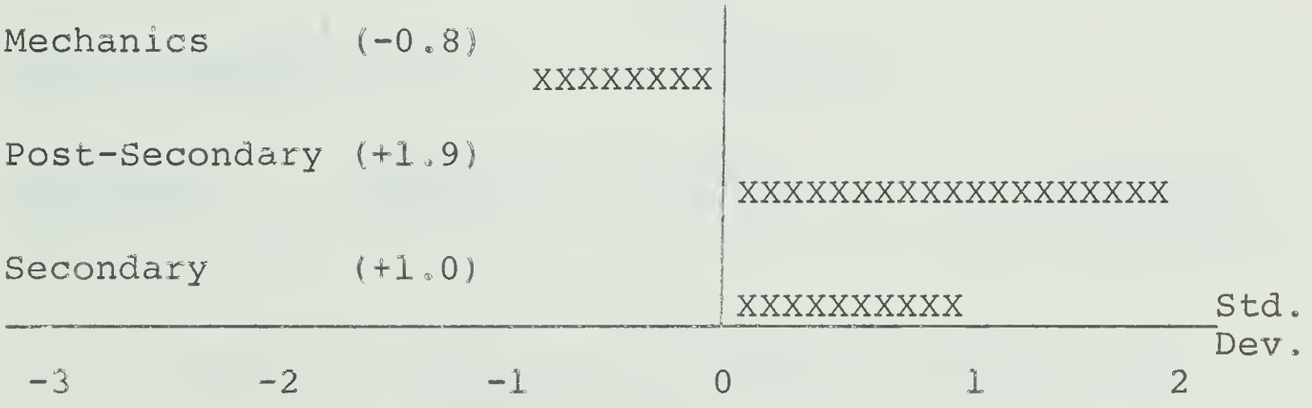

Figure 7: Relative Frequency of Doing Wheel Alignments.

Instruction time directed to skill in wheel alignment has scale values of 1.9 for post-secondary and 1.0 for secondary automotive programs, compared with -0.8 as the frequency scale value for practicing mechanics.

Use a Valve Grinder/Valve Seat Refacer

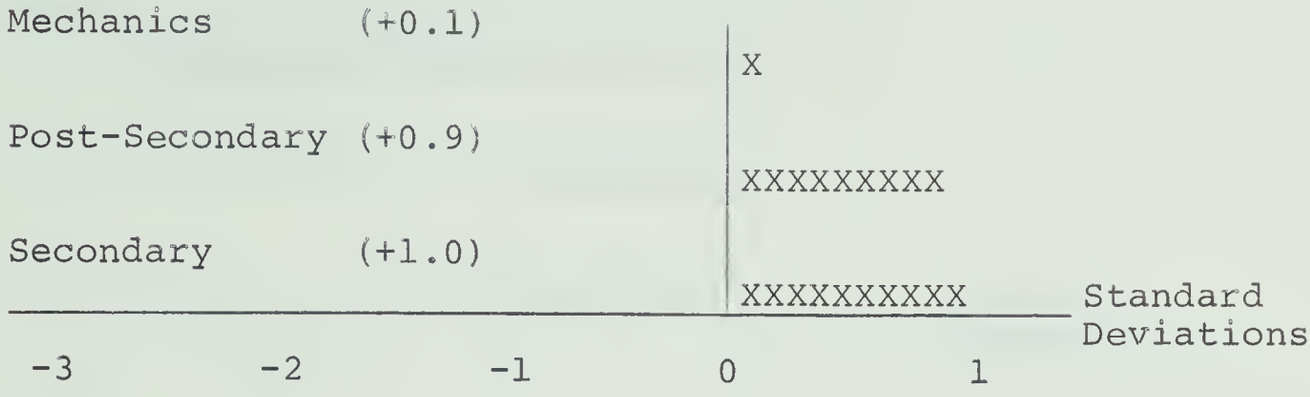

Figure 8: Relative Frequency of Valve Grinder/ Valve Seat Refacer Use.

Discrepancies between trade and training scale values were within one standard deviation.

Replace Piston Rings

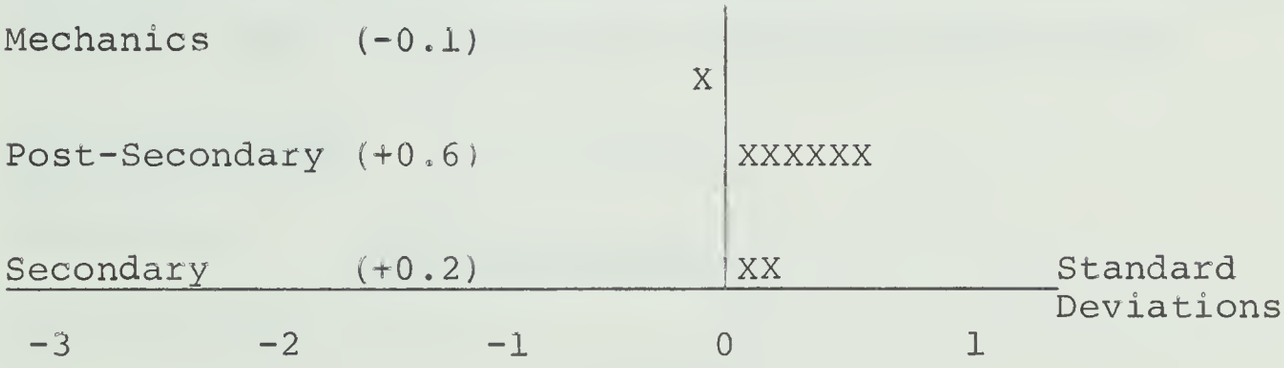

Figure 9: Relative Frequency of Piston Ring Replacing.

Discrepancies between trade and training scale values were within one standard deviation.

Robore Engine Cylinders

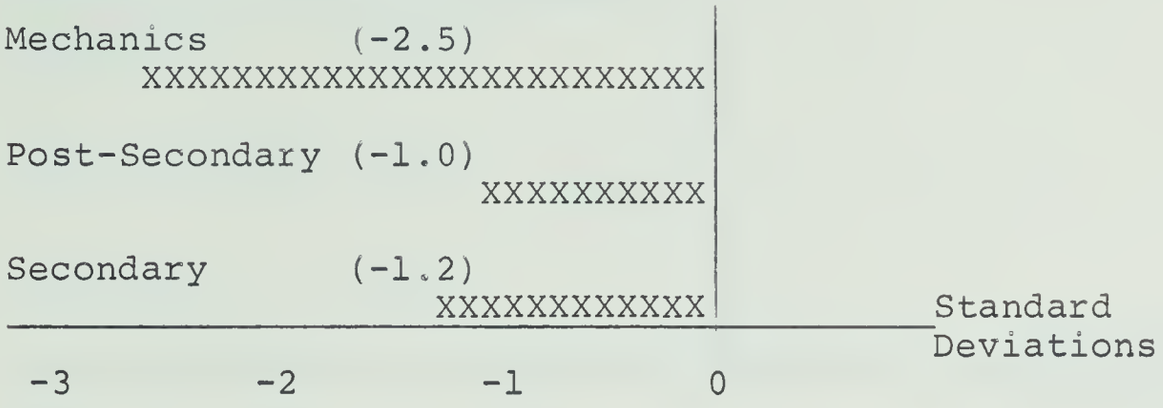

Figure 10: Relative Frequency of Engine Cylinder Reboring.

Although the results of the mechanics' reports indicated that engine cylinder reboring is very infrequently done in the trade (2.5 standard deviations below the mean), the data from secondary and post-secondary automotive instructors returned scale values of -1.2 and -1.0 respectively.

Fit Piston Pins

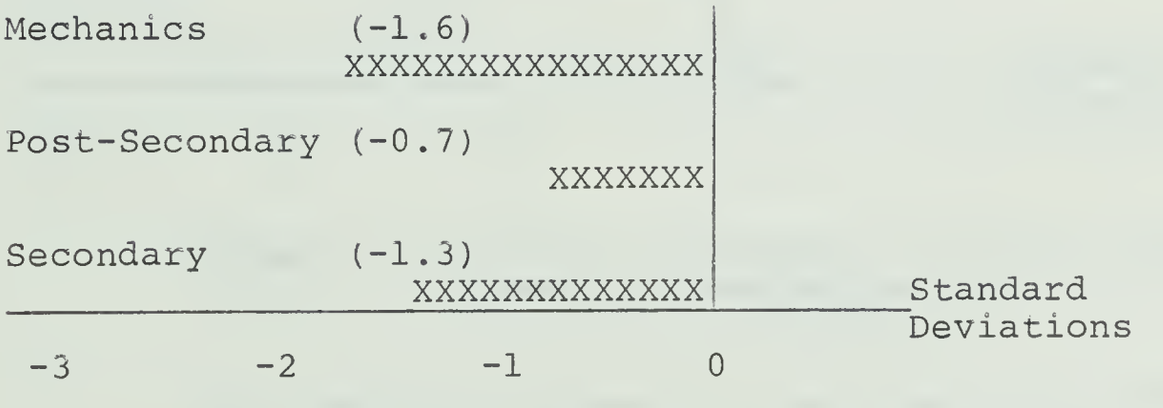

Figure 11: Relative Frequency of Piston Pin Fitting.

Discrepancies between trade and training scale values were within one standard deviation.

Replace Crankshaft Bearings

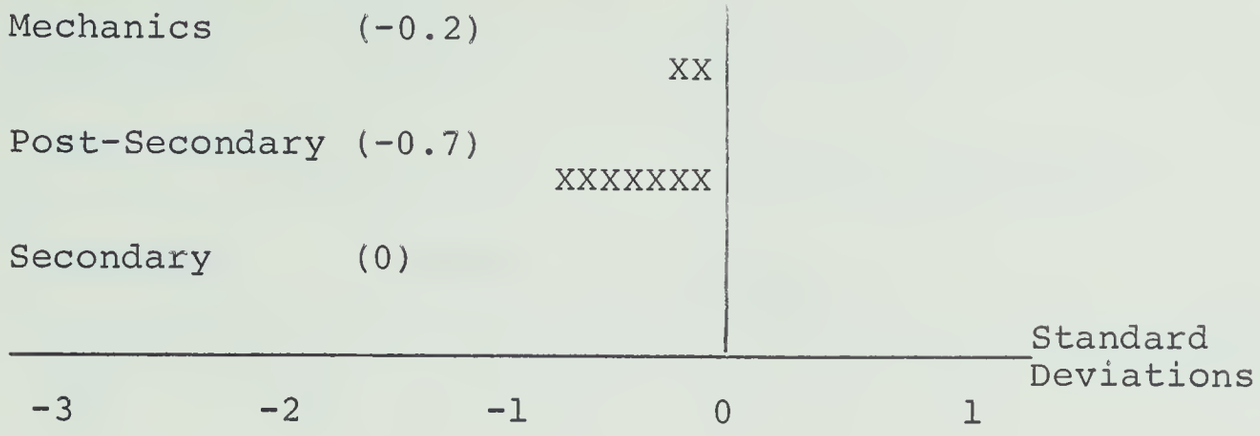

Figure 12: Relative Frequency of Crankshaft Bearing Replacing.

Discrepancies between trade and training scale values were within one standard deviation.

Replace Clutch Disc/Pressure Plate

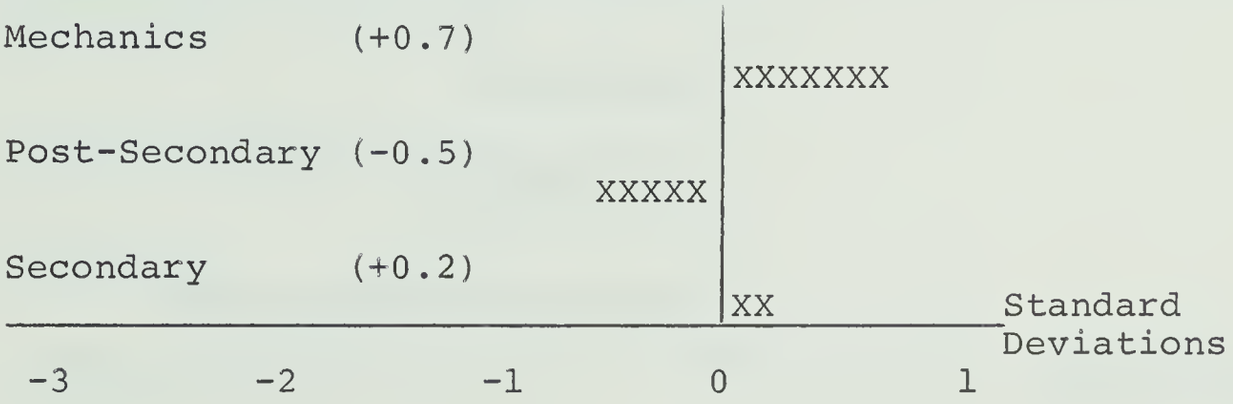

Figure 13: Relative Frequency of Clutch Disc/ Pressure Plate Replacing.

This operation appeared to be done fairly frequently by mechanics (0.7) and although instruction time spent by secondary teachers was in close agreement (0.3), post-secondary automotive instructors reported a frequency scale value of only -0.5.

Overhaul Standard Transmission

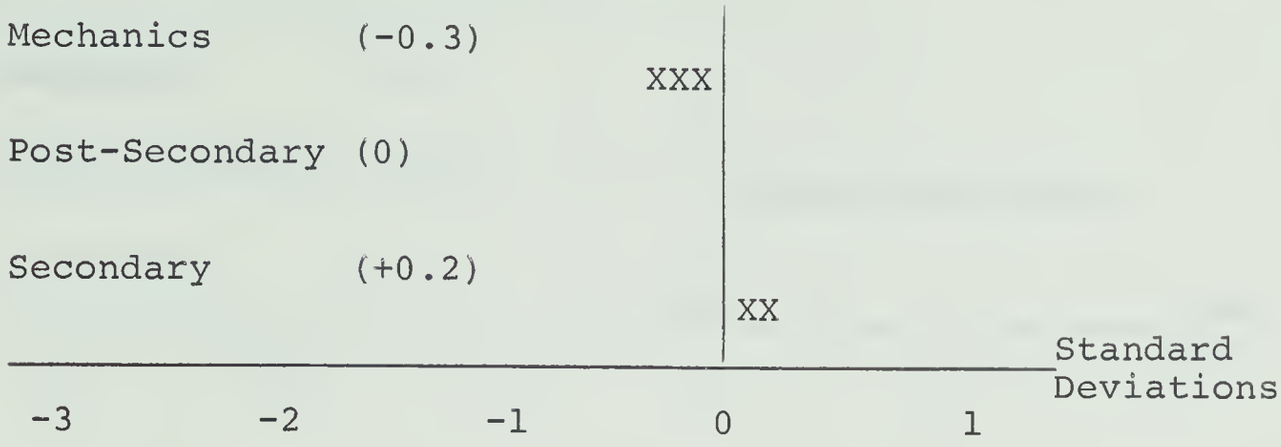

Figure 14: Relative Frequency of Standard Transmission Overhaul.

Discrepancies between trade and training scale values were within one standard deviation.

Overhaul Automatic Transmission

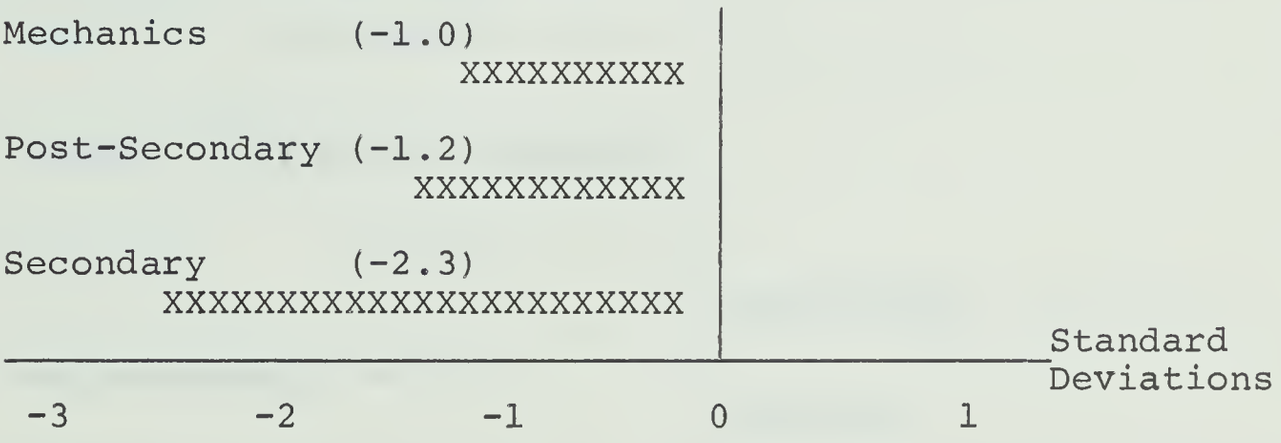

Figure 15: Relative Frequency of Automatic Transmission Overhaul.

Automotive mechanics and post-secondary automotive instructors supplied data indicating that their times spent in this operation were in close agreement (-1.0 and -1.2 respectively). Secondary school automotive teachers reported a very much lower frequency (-2.3).

Overhaul Axle Differential Assembly

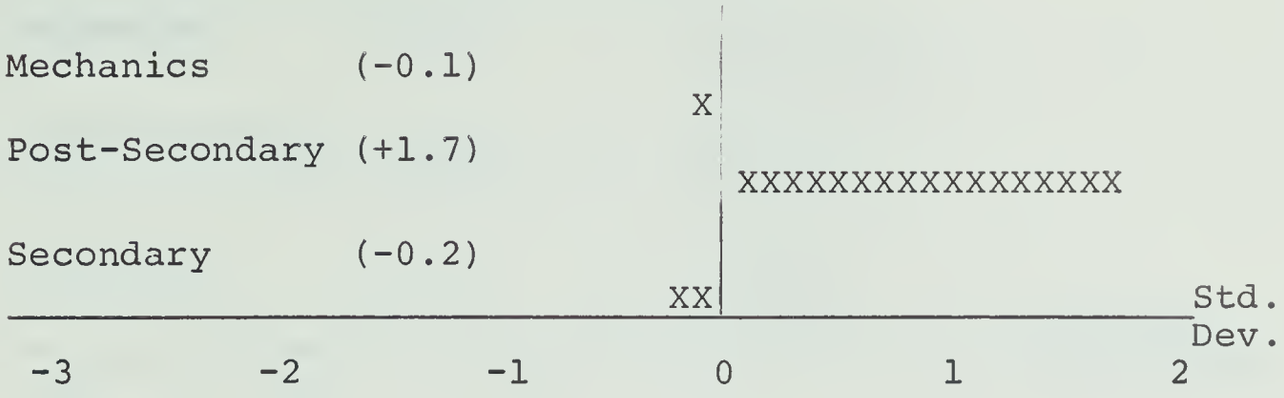

Figure 16: Relative Frequency of Axle Differntial Assembly Overhaul.

Although mechanics and secondary automotive teachers returned rather closely aligned scale values for this operation (-0.7 and -0.2), post-secondary automotive instructors indicated a much larger portion of their time directed to this skill development (1.6).

Overhaul Electrical Component

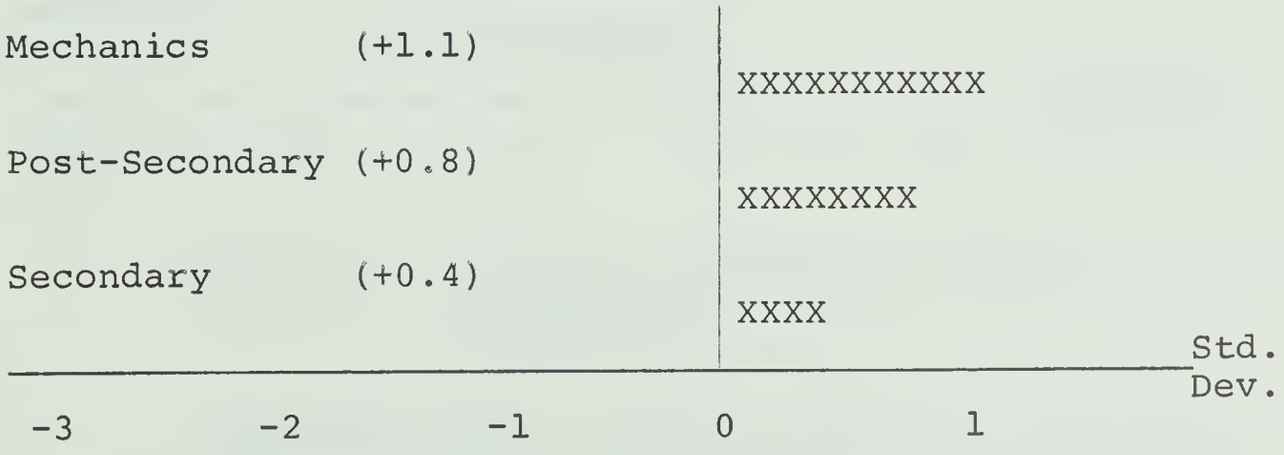

Figure 17: Relative Frequency of Electrical Component Overhaul.

Discrepancies between trade and training scale values were within one standard deviation.

Overhaul Carburetor

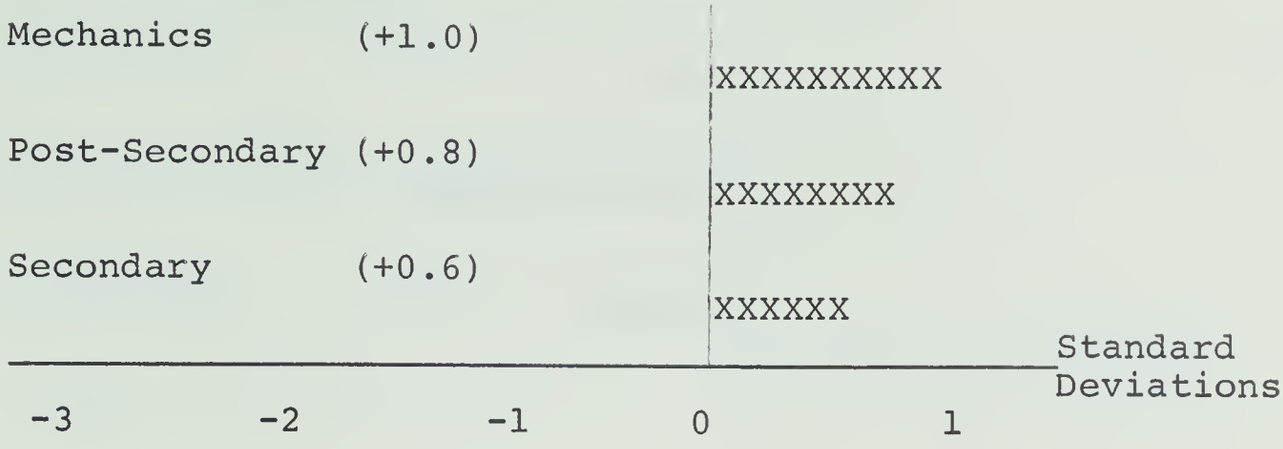

Figure 18: Relative Frequency of Carburetor Overhaul.

Discrepancies between trade and training scale values were within one standard deviation.

Adjust Voltage Regulator

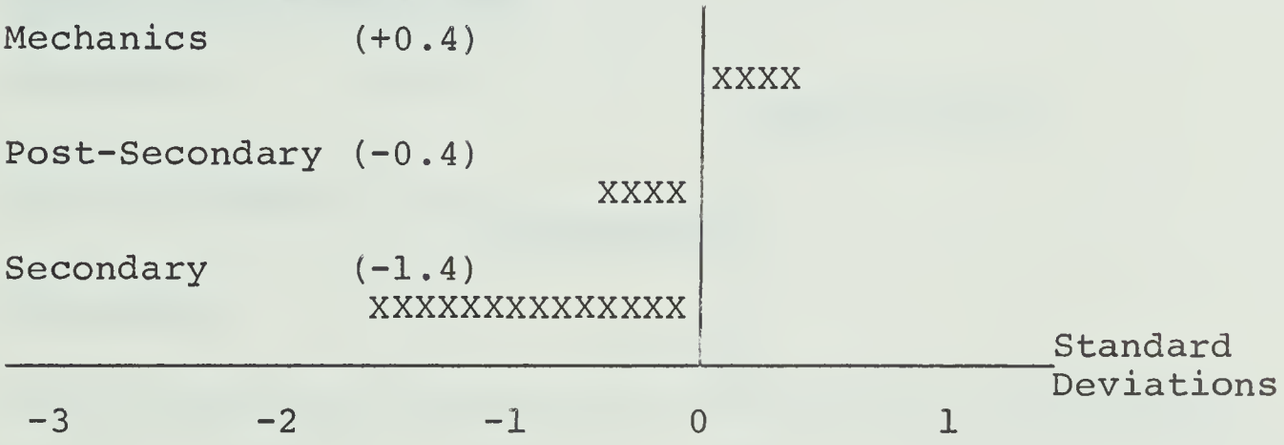

Figure 19: Relative Frequency of Voltage Regulator Adjusting.

Secondary school teachers apparently instruct in this aspect of automotive repair in a time proportion of 1.4 standard deviations below the mean, compared with 0.4 standard deviations above the mean as the frequency of performance by mechanics. Post secondary instructors committed time for this operation in the amount of 0.4 standard deviations below the mean.

Replace Standard/Automatic Transmission

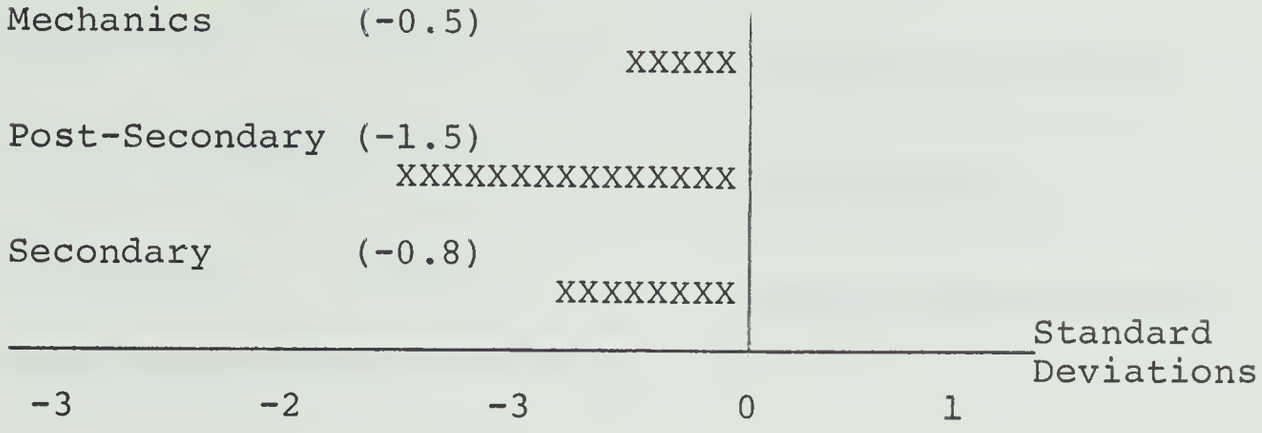

Figure 20: Relative Frequency of Standard/Automatic Transmission Replacing.

Discrepancies between trade and training scale values were within one standard deviation.

Repair Car Accessories

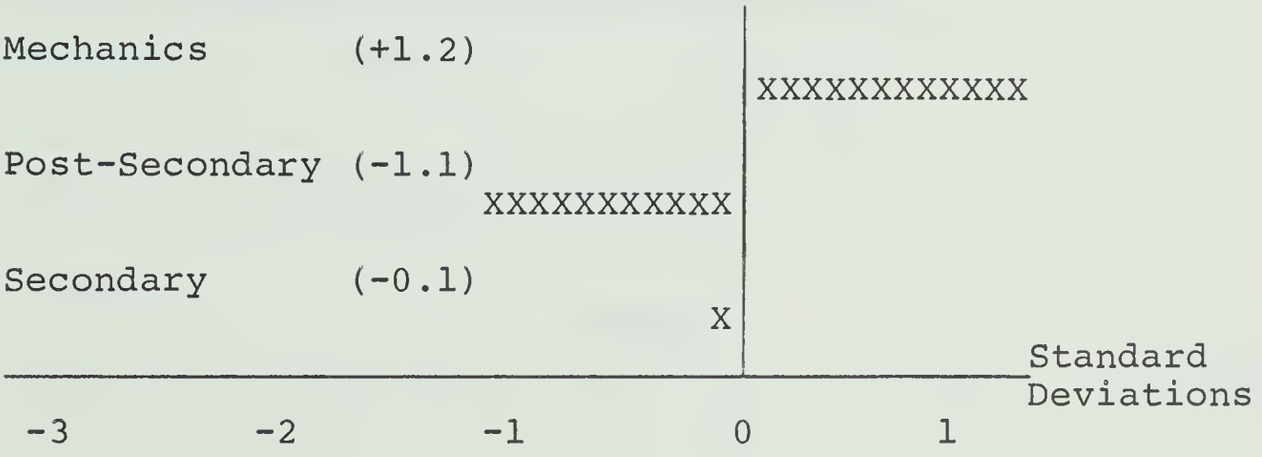

Figure 21: Relative Frequency of Car Accessory Repairing.

Although this type of activity appeared common in the trade (a frequency scale value of 1.2 standard deviations above the mean), the corresponding scale values produced from data supplied by automotive instructors was -0.1 for secondary and -1.1 for post-secondary people.

Do Minor Tune-up

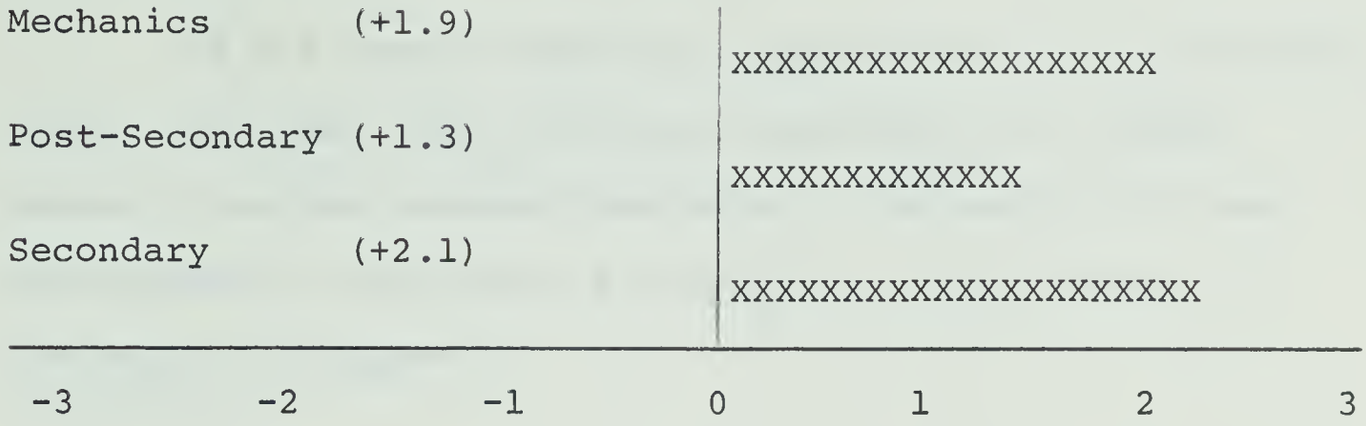

Figure 22: Relative Frequency for Performing Minor Tune-up.

Discrepancies between trade and training scale values were within one standard deviation.

Replace Carburetor/Electrical Component

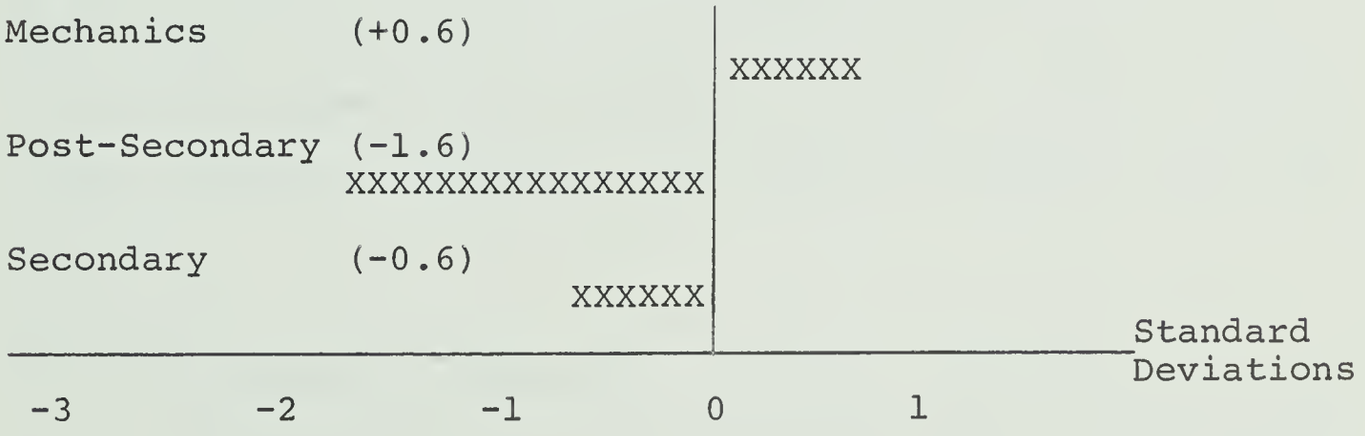

Figure 23: Relative Frequency of Carburetor/ Electrical Component Replacing.

The data from the trade yielded a scale value of 0.6 standard deviations above the mean. Scale values for data from instructors were -0.6 (secondary) and -1.6 (post-secondary).

V. SUMMARY

Of the twenty operations represented in the questionnaire, nine were trade-training misaligned in an amount greater than one standard deviation. The nature of these misalignments (and possible mitigating circumstances) is discussed in Chapter V.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The Problem

The study reported here was prompted by a question regarding the efficiency and effectiveness with which publicly supported motor vehicle repair courses are conducted. Specifically, concern was directed to the relevance of automotive curricular content in Alberta to the content of the automotive repair trade in Alberta. The purpose of this study was to provide descriptions of three things; first, automotive repair trade practice, second, automotive repair trade training, and third, the interface between trade and training.

The Populations and Samples

Answers for the above questions came from two main sources: journeymen in the motor vehicle repair trade, and automotive instructors. First, a sample of three hundred randomly selected automotive mechanics provided information about the frequency with which they did selected repair operations. Second, exhaustive samples of secondary and post-secondary automotive instructors in Alberta reported on the time they allotted to teaching toward skill in the same operations.

Methodology

In the study reported here, a questionnaire was used to obtain the desired information from the participants. To this end, twenty automotive repair operations were chosen and arranged in a paired comparisons configuration. The members of each of the three samples (mechanics, secondary automotive teachers, and post-secondary automotive instructors) were mailed packets containing a covering letter, answering instructions, a copy of the questionnaire, and a stamped self-addressed envelope.

The data contained on the returned questionnaires were analyzed according to Thurstone's model for Comparative Judgement. Sets of scale values were thus generated, first, for the frequencies with which mechanics did each of the twenty operations represented in the survey instrument, and second, for the automotive instructors' (secondary and post-secondary) proportional time commitment for instruction toward skill in the same twenty repair operations.

These sets of scale values were then compared, using two procedures. First, the Pearson's r correlation coefficient was calculated and, second, for each of the twenty operations, the three scale values (reported by mechanics, secondary automotive teachers, and post-secondary automotive instructors) were compared, and their relationships discussed.

II. CONCLUSIONS

Under the heading "Limitations Due to Research Methodology" there was mention of factors which limited the sensitivity of the survey instrument for making fine discrimination in trade-training alignment. It also should be remembered that automotive repair training at the secondary school level is not aimed at producing a "finished" mechanic. However, misalignments of more than one standard deviation between scale values for trade time and for training time existed, according to data from secondary automotive teachers, for seven of the twenty repair operations represented in the questionnaire. Misalignments of similar magnitudes existed between trade and post-secondary reports in six of the operations. Table IV, p. 61, summarized the magnitudes of these misalignments between trade data and the data supplied by the two instructors' levels.

The nine operations which were trade-training divergent by more than one standard deviation (according to one or both of the reports from the two levels of training) are discussed in detail in this chapter, and possible mitigating factors are considered.

Use a Brake Drum Lathe

Secondary automotive teachers reported a time commitment for this operation which was 1.38 standard deviations above the time reported by mechanics. No reason for this discrepancy was apparent, so this could represent inapproporiate

TABLE IV

MAGNITUDE OF SCALE VALUE* DISCREPANCIES

TRADE TIMES vs SECONDARY AND POST-SECONDARY TRAINING TIMES

Operation	Post-Secondary	Secondary
Use a Brake Drum Lathe	+0.13	+1.38
Overhaul Brake Cylinders	-0.25	+0.50
Replace Steering/Suspension Parts	-0.41	+0.14
Do Wheel Alignment	+2.68	+1.76
Use a Valve Grinder/Valve Seat Refacer	+0.89	+0.94
Replace Piston Rings	+0.67	+0.26
Rebore Engine Cylinders	+1.54	+1.31
Fit Piston Pins	+0.81	+0.28
Replace Crankshaft Bearings	-0.16	+0.18
Replace Clutch Disc/Pressure Plate	-1.16	-0.46
Overhaul Standard Transmission	+0.30	+0.46
Overhaul Automatic Transmission	-0.17	-1.13
Overhaul Axle Differential Assembly	+1.64	-0.15
Overhaul Electrical Component	-0.32	-0.70
Overhaul Carburetor	-0.12	-0.35
Adjust Voltage Regulator	-0.82	-1.76
Replace Standard/Automatic Transmission	-0.98	-0.29
Repair Car Accessories	-2.26	-1.34
Do Minor Tune-up	-0.58	+0.25
Replace Carburetor/Electrical Component	-2.18	-1.20

*NOTE: All figures expressed as discrepancies in standard deviations of unit normal scores.

portioning of time.

Do Wheel Alignment

Reports indicated that time spent instructing in wheel alignment was excessive compared with time spent performing the same operation in the trade. This apparent excess of instructional time was in the amount of 2.68 standard deviations at the post-secondary level and 1.76 standard deviations at the secondary level. Observations of automobile repair facilities suggest that this rather complex facet of automotive service is predominately done by a small number of specialists who possess the necessary skill (and expensive equipment) to do the job efficiently. In light of this situation, it seems possible that the discrepancy between trade and training times in the task of wheel alignment is not inappropriate, at least not to the extent suggested by the data.

Rebore Engine Cylinders

It appears that the increased cost of labor, relative to the price of replacement parts, has made engine reboring a rather uncommon trade practice. Although instruction in this machining operation can be used as a vehicle to present instruction in other, more frequently performed engine repair operations, it nevertheless appears that the time commitment to instruction in boring bar use was inordinately large.

Replace Clutch Disc/Pressure Plate

According to the survey data, post-secondary instructors present material on this aspect of automotive service with a time allocation 1.16 standard deviations below the comparable time spent in the trade. Clutch service, however, is relatively simple, so it is probably the case that even though it is a commonly performed trade operation, a sufficiently high skill level can be developed in automotive students in a comparatively short time.

Overhaul Automatic Transmission

Automatic transmission overhaul, as a topic of instruction in secondary schools, received a scale value 1.13 standard deviations below the level of involvement in this activity by the trade. At the time of this study, curriculum designers did not recommend this most complex aspect of automotive service for inclusion in the high school automotive program.

Overhaul Axle Differential Assembly

The time commitment for this operation by post-secondary instructors was 1.64 standard deviations above the corresponding trade time. Possibly, this is an area where the minimum time required to instruct to a conversant skill level proportionately exceeds the time required in the trade to do this type of work.

Adjust Voltage Regulator

In the case of voltage regulator adjustment, a lack

of correspondence existed between the trade and the secondary level of instruction, in the amount of -1.76 standard deviations. The curriculum guide for Automotives 12-22-32 in Alberta high schools does not recommend voltage regulator adjustment for inclusion in the course of studies.

Repair Car Accessories

This type of activity appeared, from the results of the survey, to be commonly performed in the trade, but the corresponding scale values produced from trade training data indicated that the instructional times were deficient, in the amounts of 2.25 standard deviations at the post-secondary level and 1.34 standard deviations at the secondary level. It could be argued that skill in this activity is concomitantly acquired during other training, but nevertheless, the misalignment was considerable.

Replace Carburetor/Electrical Component

Inclusion of this operation in the questionnaire was an attempt to determine two things: first, the extent to which mechanics were replacing rather than repairing components, and second, the extent to which automotive curricula are cognizant of the condition that exists in this regard. Although the discrepancies were considerable (1.20 and 2.18 standard deviations low for secondary and post-secondary instruction respectively) the existence of mitigating circumstances must be considered.

Among these are first, the possibility that the skill

required to change a component can be taught in a short time, and second, the probability that the component replacing skills are constituents of the component repairing skills which received instruction times in closer correspondence with their trade practice times.

III. RECOMMENDATIONS

The trade-training misalignments documented in the preceding section led the researcher to conclude that there should be a rethinking, and possibly a revision, of certain automotive curriculum guide recommendations. However, before the action stage can be recommended, these areas of apparent inappropriateness in curriculum content and time allocation need to be looked at in more detail. The following are recommendations for further research:

1. Results of this study suggest that the portioning of automotive instruction time may, in some respects, be inappropriate. For example, the amount of instructional time directed to the development of skill in the use of a boring bar appears excessive, because this skill is very infrequently used in the trade. Conversely, practitioners in the motor vehicle repair trade seem to spend a substantial amount of time repairing car accessories, yet this area of training is largely ignored by schools and technical institutes. Any operation which has a gross misalignment between trade and training times

(and no mitigating circumstance), needs to be explored in depth. Some attempt should be made to quantify, or at least objectively analyze, the contribution that training in such an operation makes toward the development of a mechanic. Research of this type would justify the making of concrete recommendations regarding specific curricular topics.

2. Another avenue for further research might be to poll recently certified mechanics for their reaction to the trade training they completed. Such a study could seek to determine if mechanics felt their training was insufficient in certain areas to prepare them for the demands of the trade, and if their technical training in other areas was excessive or irrelevant to their subsequent job requirements.
3. An alternate study would use the design described in the second recommendation for further research (immediately above) except the source of data would not be mechanics, but rather their immediate supervisors, the shop foremen. Comments on the effectiveness of automotive repair trade training, given from the point of view of lower management might contain some insightful and useful information.
4. It should be noted that only the automotive repair trade and its publicly supported service courses have been investigated in this study. With a more global view, it is suggested that research directed

to other trades and occupations (e.g. machine shop, building construction, electricity-electronics, etc.) might be warranted.

BIBLIOGRAPHY

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Books

Allen, C. R. The Instructor, The Man, and The Job. Philadelphia: J. B. Lippincott Co., 1919.

Allen, W. A. Know Your Car. Chicago: American Technical Society, 1960.

Crouse, W. A. Automotive Mechanics. (5th ed.) New York: McGraw-Hill, 1965.

DeCecco, J. P. The Psychology of Learning and Instruction. New Jersey: Prentice-Hall, Inc., 1968.

Ferguson, G. A. Statistical Analysis in Psychology and Education. New York: McGraw-Hill, 1966.

Fisher, R. A. and Yates, F. Statistical Tables for Biological, Agricultural and Medical Research. (6th ed.) London: Oliver and Boyd Ltd., 1963.

Frazee, I. and E. L. Bedell. Tractors and Crawlers. Chicago: American Technical Society, 1957.

Fryklund, V. C. Analysis Technique for Instructors. Milwaukee: Bruce Publishing, 1965.

Thorndike, R. L. and Hagen, E. Measurement and Evaluation in Psychology and Education. New York: John Wiley and Sons, 1969.

Tobolt, W. K. and J. Purvis. Automotive Encyclopedia. Homewood, Ill.: Goodheart-Wilcox, 1965.

Thurstone, L. L. The Measurement of Attitude. Chicago: The University of Chicago Press, 1959.

Torgerson, W. S. Theory and Methods of Scaling. New York: John Wiley and Sons, 1958.

Canadian Service Data Book. Toronto: Maclean-Hunter, 1968.

Motors Flat Rate and Parts Manual. New York: Motor, 1970.

Publications of Governments, Learned Societies, and Other Organizations

Alberta Department of Education. Senior High School Curriculum Guide Vocational Series Automotives 12-22-32. Edmonton: Government of Alberta, 1966.

Alberta Department of Labor. Detailed Course Outline for Motor Mechanic Apprentices. Edmonton: Government of Alberta, 1968.

Government of Alberta. The Alberta Gazette. Edmonton: The Queen's Printer, May 31, 1965.

Canadian Department of Labor. An Analysis of the Motor Vehicle Repair Trade. Ottawa: The Queen's Printer, 1957.

Allen, D. A National Study of the Aviation Mechanics Occupation. A Cooperative Study of the Division of Vocational Education, University of California, Los Angeles; Bureau of Industrial Education, California State Department of Education; and U.S. Office of Education, 1966.

Unpublished Materials

Rinck, J. "A Comparative Study in Aviation Airframe and Power Plant Mechanics--Needs of the Mechanics as They Relate to Content in the Secondary Schools and Suggestions for Course Content in the Technical and Secondary Schools." Unpublished Doctoral dissertation, Colorado State College, 1968.

Snitz, R. H. "An Analysis of the Sheet Metal Worker's Trade and a Curriculum for the Training of Teachers of Sheet Metal Work in Industiral Arts Courses." Unpublished Doctoral dissertation, Indiana University, 1931.

Periodicals

Edmonton Journal, Edmonton: Southam News, Dec. 16, 1970.

APPENDIX A

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)USE A BRAKE DRUM LATHE

(__)OVERHAUL BRAKE CYLINDERS
(__)FIT PISTON PINS

(__)USE A BRAKE DRUM LATHE
(__)DO MINOR TUNE-UP

(__)REBORE ENGINE CYLINDERS
(__)OVERHAUL BRAKE CYLINDERS

(__)OVERHAUL ELECTRICAL COMPONENT
(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY

(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION
(__)ADJUST VOLTAGE REGULATOR

(__)DO WHEEL ALIGNMENT
(__)OVERHAUL STANDARD TRANSMISSION

(__)OVERHAUL ELECTRICAL COMPONENT
(__)DO MINOR TUNE-UP

(__)OVERHAUL CARBURETOR
(__)ADJUST VOLTAGE REGULATOR

(__)REBORE ENGINE CYLINDERS
(__)OVERHAUL STANDARD TRANSMISSION

(__)REBORE ENGINE CYLINDERS
(__)REPLACE PISTON RINGS

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)OVERHAUL BRAKE CYLINDERS

(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION
(__)REPLACE PISTON RINGS

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(__)USE A BRAKE DRUM LATHE

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(__)OVERHAUL STANDARD TRANSMISSION

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(__)ADJUST VOLTAGE REGULATOR

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(__)REPAIR CAR ACCESSORIES

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(__)REPLACE STEERING/SUSPENSION PARTS
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(__)USE A BRAKE DRUM LATHE
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)REPAIR CAR ACCESSORIES
(__)REPLACE CRANKSHAFT BEARINGS

(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION
(__)OVERHAUL CARBURETOR

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(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION

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(__)ADJUST VOLTAGE REGULATOR

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(__)USE A BRAKE DRUM LATHE
(__)OVERHAUL STANDARD TRANSMISSION

(__)OVERHAUL AUTOMATIC TRANSMISSION
(__)REPLACE CRANKSHAFT BEARINGS

(__)FIT PISTON PINS
(__)REPAIR CAR ACCESSORIES

(__)REBORE ENGINE CYLINDERS
(__)DO MINOR TUNE-UP

(__)OVERHAUL ELECTRICAL COMPONENT
(__)REPLACE PISTON RINGS

(__)DO MINOR TUNE-UP
(__)OVERHAUL CARBURETOR

(__)REPLACE STEERING/SUSPENSION PARTS
(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT

(__)FIT PISTON PINS
(__)REBORE ENGINE CYLINDERS

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)REPLACE PISTON RINGS

(__)USE A BRAKE DRUM LATHE
(__)REPAIR CAR ACCESSORIES

(__)REPLACE PISTON RINGS
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)OVERHAUL CARBURETOR
(__)REPLACE PISTON RINGS

(__)DO WHEEL ALIGNMENT
(__)FIT PISTON PINS

(__)USE A VALVE GRINDER/VALVE SEAT REFACER
(__)ADJUST VOLTAGE REGULATOR

(__)REPAIR CAR ACCESSORIES
(__)OVERHAUL ELECTRICAL COMPONENT

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)DO MINOR TUNE-UP

(__)REPLACE CLUTCH DISC/PRESSURE PLATE
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION
(__)OVERHAUL ELECTRICAL COMPONENT

(__)OVERHAUL AUTOMATIC TRANSMISSION
(__)FIT PISTON PINS

(__)DO MINOR TUNE-UP
(__)OVERHAUL STANDARD TRANSMISSION

(__)DO MINOR TUNE-UP
(__)REPLACE PISTON RINGS

(__)REPAIR CAR ACCESSORIES
(__)USE A VALVE GRINDER/VALVE SEAT REFACER

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)DO WHEEL ALIGNMENT

(__)FIT PISTON PINS
(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY

(__)OVERHAUL BRAKE CYLINDERS
(__)REPLACE CRANKSHAFT BEARINGS

(__)OVERHAUL STANDARD TRANSMISSION
(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION

(__)OVERHAUL ELECTRICAL COMPONENT
(__)REPLACE CLUTCH DISC/PRESSURE PLATE

(__)OVERHAUL STANDARD TRANSMISSION
(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)OVERHAUL STANDARD TRANSMISSION

(__)DO MINOR TUNE-UP
(__)REPLACE CRANKSHAFT BEARINGS

(__)OVERHAUL BRAKE CYLINDERS
(__)REPLACE STEERING/SUSPENSION PARTS

(__)USE A VALVE GRINDER/VALVE SEAT REFACER
(__)OVERHAUL CARBURETOR

(__)OVERHAUL BRAKE CYLINDERS
(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY

(__)DO WHEEL ALIGNMENT
(__)REPLACE CLUTCH DISC/PRESSURE PLATE

(__)USE A BRAKE DRUM LATHE
(__)REPLACE CLUTCH DISC/PRESSURE PLATE

(__)REPLACE STEERING/SUSPENSION PARTS
(__)DO WHEEL ALIGNMENT

(__)REPLACE CRANKSHAFT BEARINGS
(__)REBORE ENGINE CYLINDERS

(__)OVERHAUL AUTOMATIC TRANSMISSION
(__)REPLACE STEERING/SUSPENSION PARTS

(__)ADJUST VOLTAGE REGULATOR
(__)FIT PISTON PINS

(__)DO WHEEL ALIGNMENT
(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION

(__)REPLACE CLUTCH DISC/PRESSURE PLATE
(__)OVERHAUL STANDARD TRANSMISSION

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)REPAIR CAR ACCESSORIES

(__)REPLACE PISTON RINGS
(__)DO WHEEL ALIGNMENT

(__)OVERHAUL BRAKE CYLINDERS
(__)REPLACE PISTON RINGS

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)USE A VALVE GRINDER/VALVE SEAT REFACER

(__)USE A VALVE GRINDER/VALVE SEAT REFACER
(__)USE A BRAKE DRUM LATHE

(__)REPLACE CLUTCH DISC/PRESSURE PLATE
(__)REPLACE PISTON RINGS

(__)FIT PISTON PINS
(__)DO MINOR TUNE-UP

(__)FIT PISTON PINS
(__)REPLACE STEERING/SUSPENSION PARTS

(__)DO MINOR TUNE-UP
(__)DO WHEEL ALIGNMENT

(__)REBORE ENGINE CYLINDERS
(__)OVERHAUL CARBURETOR

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)REPLACE CLUTCH DISC/PRESSURE PLATE

(__)OVERHAUL CARBURETOR
(__)OVERHAUL BRAKE CYLINDERS

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)REPLACE CLUTCH DISC/PRESSURE PLATE

(__)OVERHAUL CARBURETOR
(__)REPAIR CAR ACCESSORIES

(__)FIT PISTON PINS
(__)OVERHAUL CARBURETOR

(__)REPLACE CRANKSHAFT BEARINGS
(__)REPLACE STEERING/SUSPENSION PARTS

(__)REPAIR CAR ACCESSORIES
(__)REPLACE STEERING/SUSPENSION PARTS

(__)OVERHAUL STANDARD TRANSMISSION
(__)OVERHAUL BRAKE CYLINDERS

(__)USE A BRAKE DRUM LATHE
(__)OVERHAUL CARBURETOR

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)OVERHAUL CARBURETOR

(__)DO WHEEL ALIGNMENT
(__)REPAIR CAR ACCESSORIES

(__)FIT PISTON PINS
(__)OVERHAUL STANDARD TRANSMISSION

(__)OVERHAUL ELECTRICAL COMPONENT
(__)DO WHEEL ALIGNMENT

(__)REPLACE CLUTCH DISC/PRESSURE PLATE
(__)REPAIR CAR ACCESSORIES

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)OVERHAUL CARBURETOR

(__)USE A VALVE GRINDER/VALVE SEAT REFACER
(__)OVERHAUL STANDARD TRANSMISSION

(__)REBORE ENGINE CYLINDERS
(__)REPLACE CLUTCH DISC/PRESSURE PLATE

(__)REPAIR CAR ACCESSORIES
(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY

(__)ADJUST VOLTAGE REGULATOR
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)DO MINOR TUNE-UP
(__)REPLACE STEERING/SUSPENSION PARTS

(__)DO WHEEL ALIGNMENT
(__)REPLACE CRANKSHAFT BEARINGS

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)FIT PISTON PINS

(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION
(__)REPAIR CAR ACCESSORIES

(__)REPLACE CRANKSHAFT BEARINGS
(__)USE A BRAKE DRUM LATHE

(__)REBORE ENGINE CYLINDERS
(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT

(__)REBORE ENGINE CYLINDERS
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)OVERHAUL STANDARD TRANSMISSION
(__)OVERHAUL ELECTRICAL COMPONENT

(__)USE A VALVE GRINDER/VALVE SEAT REFACER
(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION

(__)USE A VALVE GRINDER/VALVE SEAT REFACER
(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT

(__)USE A VALVE GRINDER/VALVE SEAT REFACER
(__)FIT PISTON PINS

(__)REPAIR CAR ACCESSORIES
(__)DO MINOR TUNE-UP

(__)FIT PISTON PINS
(__)REPLACE PISTON RINGS

(__)REPLACE STEERING/SUSPENSION PARTS
(__)USE A VALVE GRINDER/VALVE SEAT REFACER

(__)REPLACE CLUTCH DISC/PRESSURE PLATE
(__)REPLACE CRANKSHAFT BEARINGS

(__)DO WHEEL ALIGNMENT
(__)USE A VALVE GRINDER/VALVE SEAT REFACER

(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)DO MINOR TUNE-UP
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)REPLACE STEERING/SUSPENSION PARTS
(__)REPLACE PISTON RINGS

(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION
(__)REPLACE STEERING/SUSPENSION PARTS

(__)OVERHAUL CARBURETOR
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)DO MINOR TUNE-UP
(__)ADJUST VOLTAGE REGULATOR

(__)OVERHAUL ELECTRICAL COMPONENT
(__)REBORE ENGINE CYLINDERS

(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION
(__)FIT PISTON PINS

(__)OVERHAUL ELECTRICAL COMPONENT
(__)OVERHAUL AUTOMATIC TRANSMISSION

(__)OVERHAUL ELECTRICAL COMPONENT
(__)OVERHAUL CARBURETOR

(__)OVERHAUL CARBURETOR
(__)REPLACE CRANKSHAFT BEARINGS

(__)DO MINOR TUNE-UP
(__)REPLACE STANDARD/AUTOMATIC TRANSMISSION

(__)ADJUST VOLTAGE REGULATOR
(__)OVERHAUL STANDARD TRANSMISSION

(__)DO WHEEL ALIGNMENT
(__)REBORE ENGINE CYLINDERS

(__)DO MINOR TUNE-UP
(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT

(__)OVERHAUL AUTOMATIC TRANSMISSION
(__)USE A VALVE GRINDER/VALVE SEAT REFACER

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT

(__)OVERHAUL STANDARD TRANSMISSION
(__)REPLACE CRANKSHAFT BEARINGS

(__)OVERHAUL AXLE DIFFERENTIAL ASSEMBLY
(__)REBORE ENGINE CYLINDERS

(__)REPLACE PISTON RINGS
(__)REPLACE CARBURETOR/ELECTRICAL COMPONENT

(__)OVERHAUL STANDARD TRANSMISSION
(__)OVERHAUL CARBURETOR

* * * *

APPENDIX B

FACULTY OF EDUCATION
DEPARTMENT OF INDUSTRIAL AND
VOCATIONAL EDUCATION

THE UNIVERSITY OF ALBERTA
EDMONTON 7, ALBERTA, CANADA

March 4, 1971

Within the Department of Industrial and Vocational Education and with the co-operation of the Apprenticeship and Tradesmen's Qualification Branch of the Alberta Department of Labor, research is being conducted in an attempt to determine how much time is spent in the motor vehicle repair trade doing various service and repair operations. The hope is to gather information which will be helpful in improving the high school and technical institute courses of study in automotives.

In order to do this, the names of a large number of automotive mechanics (including your own) were selected from the records of the Apprenticeship Board. Each mechanic in the group has been sent a questionnaire identical to the one enclosed, and you are asked to fill yours out according to the instructions on the first page, and mail it back in the stamped self-addressed envelope before March 15.

All replies will be treated confidentially and when the study is completed each mechanic who filled out and mailed his questionnaire will be sent a summary of the findings, both for general information and to allow him to compare his own trade activities with the provincial averages. The more replies we receive, the more accurate the findings will be, so your co-operation in this matter certainly will be appreciated.

Please accept my thanks.

QUESTIONNAIRE INSTRUCTIONS

This questionnaire has been produced in the hope that the results will tell us something about how often mechanics in Alberta do certain types of repairs on vehicles. Every question consists of a pair of jobs or repair operations and in each case you are asked to mark the one that you personally have done most often in the past year. For example:

(X) OVERHAUL CARBURETOR	(X) DO MINOR TUNE-UP
( ) REPLACE STANDARD/AUTOMATIC TRANSMISSION	( ) FIT PISTON PINS

-the mechanic who answered the above two questions overhauls carburetors more often than he replaces transmissions, and he does minor tune-up's more often than he fits piston pins. If you come to a pair in which you have never done either of the two operations in the past year, leave that question blank.

Note that a number of the questions distinguish between replacing a component and actually rebuilding or overhauling it. Below are further explanations for some of the terms used in the questionnaire:

OVERHAUL ELECTRICAL COMPONENT-*would include overhaul of starter, generator, or distributor. Overhauling distributor would include replacing bushings, and setting the vacuum and centrifugal advances. Replacing points, condenser, rotor, or distributor cap would come under minor tune-up.*

REPLACE CRANKSHAFT BEARINGS-*would include main bearings, connecting rod bearings, or both.*

REPAIR CAR ACCESSORIES-*would include work on lights, horn, heater, dashboard gauges, door latches, window regulators, convertible power top mechanisms, windshield wipers/washers, etc.*

DO MINOR TUNE-UP-*would include replace points, spark plugs, condenser, and set idle.*

Your assistance in filling out this questionnaire is greatly appreciated. Thank you.

APPENDIX C

FACULTY OF EDUCATION
DEPARTMENT OF INDUSTRIAL AND
VOCATIONAL EDUCATION

THE UNIVERSITY OF ALBERTA
EDMONTON 7, ALBERTA, CANADA

March 25, 1971

Within the Department of Industrial and Vocational Education and with the co-operation of the Apprenticeship and Tradesmen's Qualification Branch of the Alberta Department of Labor, research is being conducted in an attempt to determine the distribution of time, in automotive courses, that is devoted to training in each of a number of service and repair operations. The hope is to gather information which will be helpful in determining the provincial averages for portions of time directed to instruction and practice in specific job skills.

In order to do this, each member of a randomly selected sample of automotive instructors has been sent a questionnaire identical to the one enclosed, and you are asked to fill yours out according to the instructions on the first page, and mail it back in the stamped self-addressed envelope by March 31.

All replies will be treated confidentially and when the study is completed, each instructor who filled out and mailed his questionnaire will be sent a summary of the findings, for his own general information. The more replies we receive, the more accurate the findings will be, so your co-operation in this matter certainly will be appreciated.

Please accept my thanks.

Yours truly,

QUESTIONNAIRE INSTRUCTIONS

This questionnaire has been produced in the hope that the results will tell us something about how much of an automotive student's time is spent receiving instruction (including both practice and theory) related to certain mechanical skills. Every question consists of a pair of jobs or repair operations and in each case you are asked to mark the one that you personally have spent the most time teaching toward in the past year. For example.

(X) OVERHAUL CARBURETOR
( ) REPLACE STANDARD/AUTOMATIC TRANSMISSION

( ) DO MINOR TUNE-UP
(X) FIT PISTON PINS

The instructor who answered the above two questions spends more time teaching carburetor overhauling that he does teaching transmission replacement, and he spends more time teaching pin fitting than he does teaching minor tune-up. If you come to a pair in which you do not teach either of the two operations, then leave that question blank.

Note that a number of the questions distinguish between replacing a component and actually rebuilding or overhauling it. Below are further explanations for some of the terms used in the questionnaire.

OVERHAUL ELECTRICAL COMPONENT-*would include overhaul of starter, generator, alternator, or distributor. Overhauling distributor would include replacing bushings and setting the vacuum and centrifugal advances. Replacing points, condenser, rotor, or distributor cap would come under minor tune-up.*

REPLACE CRANKSHAFT BEARINGS-*would include main bearings, connecting rod bearings, or both.*

REPAIR CAR ACCESSORIES-*would include work on lights, horn, heater, dashboard gauges, door latches, window regulators, convertible power top mechanisms, windshield washers/wipers, etc.*

DO MINOR TUNE-UP-*would include replace points, spark plugs, condenser, and set idle and timing.*

Your assistance in filling out this questionnaire is greatly appreciated. Thank you.

APPENDIX D

PLEASE COMPLETE THE QUESTIONNAIRE ACCORDING TO THE INSTRUCTIONS ON PAGE 1, EXCEPT THAT INSTEAD OF MARKING THE OPERATION IN EACH PAIR THAT YOU PERSONALLY HAVE DONE THE MOST OFTEN, MARK THE ONE THAT, IN YOUR OPINION, HAS BEEN DONE MOST OFTEN BY THE TRADE AS A WHOLE, IN THE PAST YEAR.

THANK YOU.

APPENDIX E

NUMBER OF RESPONDENTS TO EACH PAIR*

J=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
I= 1	0	206	205	125	159	183	103	137	190	211	200	129	198	217	211	204	179	221	225	217
I= 2	206	0	198	202	208	204	210	206	205	192	202	207	207	215	214	217	205	212	214	214
I= 3	205	198	0	189	205	196	200	193	193	194	199	197	197	212	202	205	199	208	209	206
I= 4	125	202	189	0	157	171	94	115	175	207	191	122	193	217	209	204	164	217	215	211
I= 5	159	208	205	157	0	167	139	140	168	208	186	145	186	215	199	212	190	215	215	210
I= 6	183	204	196	171	167	0	158	156	132	199	180	161	178	209	203	211	175	214	214	208
I= 7	103	210	200	94	139	158	0	83	151	207	181	79	180	211	202	194	156	212	219	207
I= 8	137	206	193	115	140	156	83	0	157	207	179	104	177	212	205	197	161	221	218	208
I= 9	190	205	193	175	168	132	151	157	0	199	180	164	178	211	202	210	181	215	214	211
I=10	211	192	194	207	208	199	207	207	199	0	195	208	198	216	215	214	196	211	208	211
I=11	200	202	199	191	186	180	181	179	180	195	0	179	176	208	207	210	186	212	212	201
I=12	129	207	197	122	145	161	79	104	164	208	179	0	181	217	209	202	162	221	218	209
I=13	198	207	197	193	186	178	180	177	178	198	176	181	0	212	204	209	189	212	212	214
I=14	217	215	212	217	215	209	211	212	211	216	208	217	212	0	199	197	215	203	204	205
I=15	211	214	202	209	199	203	202	205	202	215	207	209	204	199	0	194	209	203	205	201
I=16	204	217	205	204	212	211	194	197	210	214	210	202	209	197	194	0	205	208	208	198
I=17	179	205	199	164	190	175	156	161	181	196	186	162	189	215	209	205	0	216	216	198
I=18	221	212	208	217	215	214	222	221	215	211	212	221	212	203	203	208	216	0	204	219
I=19	225	214	209	215	215	214	219	218	214	206	212	218	212	204	205	208	216	204	0	206
I=20	217	214	206	211	210	208	207	208	211	211	201	209	212	205	201	198	198	210	206	0

*Index numbers refer to operations listed in Table I, p. 28.

MATRIX OF PROPORTIONS*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.50	0.80	0.31	0.47	0.63	0.66	0.15	0.39	0.62	0.71	0.55	0.40	0.69	0.52	0.82	0.80	0.61	0.36	0.91	[illegible]
2	0.20	0.50	0.44	0.18	0.36	0.28	0.04	0.11	0.24	0.56	0.25	0.15	0.29	0.64	0.67	0.53	0.26	0.71	0.84	[illegible]
3	0.19	0.56	0.50	0.21	0.36	0.27	0.03	0.09	0.27	0.51	0.32	0.16	0.36	0.71	0.66	0.55	0.19	0.72	0.85	[illegible]
4	0.53	[illegible]	[illegible]	0.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.71	0.42	0.70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	0.37	0.64	0.62	0.31	0.50	0.38	[illegible]	[illegible]	0.41	0.60	0.45	0.24	0.51	0.75	0.75	[illegible]	0.42	[illegible]	[illegible]	[illegible]
6	0.34	0.72	0.73	0.32	[illegible]	0.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.81	[illegible]	0.46	[illegible]	[illegible]	[illegible]	[illegible]
7	0.85	0.96	0.96	0.84	0.98	0.97	0.50	0.90	0.99	0.98	0.97	0.78	0.95	0.98	0.97	0.94	0.92	[illegible]	0.97	[illegible]
8	0.61	0.89	0.91	0.59	0.91	0.96	0.10	0.50	0.95	0.94	0.87	[illegible]	[illegible]	0.90	0.92	0.87	0.83	[illegible]	[illegible]	[illegible]
9	0.38	0.76	0.73	0.31	0.59	0.74	0.01	[illegible]	0.50	0.77	[illegible]	0.25	0.62	0.79	0.82	0.66	0.45	0.80	[illegible]	[illegible]
10	0.29	0.44	0.49	0.24	0.40	0.22	[illegible]	[illegible]	0.23	[illegible]	0.10	[illegible]	0.25	0.73	0.60	0.49	0.19	[illegible]	[illegible]	[illegible]
11	0.34	0.75	0.68	0.29	0.55	0.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.32	0.45	[illegible]	[illegible]	0.70	[illegible]	[illegible]	[illegible]	[illegible]
12	0.60	[illegible]	[illegible]	0.58	0.76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	0.31	0.71	0.70	0.30	[illegible]	0.44	[illegible]	[illegible]	[illegible]	0.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	0.18	0.36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	0.20	0.47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	0.39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AVG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Index numbers refer to operations listed in Table I, p. 28.

APPENDIX F

NUMBER OF RESPONDENTS IN EACH PAIR *

J=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
I= 1	0	26	29	28	27	29	26	29	30	29	26	27	30	27	27	26	27	29	28	30
I= 2	26	0	26	29	26	29	30	30	30	27	29	28	29	28	26	29	29	26	29	30
I= 3	29	28	0	28	29	28	26	30	29	25	27	29	29	29	29	30	28	30	28	29
I= 4	28	29	28	0	28	28	27	29	29	29	29	28	27	29	29	28	29	30	29	29
I= 5	27	28	29	28	0	26	26	27	26	29	29	28	29	27	27	28	28	29	29	28
I= 6	29	29	28	28	26	0	25	24	29	25	29	24	27	28	29	25	29	27	25	27
I= 7	28	30	28	27	26	25	0	21	25	25	29	25	26	25	26	22	25	29	28	27
I= 8	29	30	30	29	27	24	21	0	24	29	29	22	28	27	26	24	26	28	29	26
I= 9	30	30	29	29	26	29	25	24	0	29	29	26	29	27	28	26	26	29	29	28
I=10	29	27	25	29	29	28	28	29	29	0	26	28	27	28	28	27	25	29	29	28
I=11	28	29	27	29	29	29	29	29	29	26	0	29	28	28	27	29	28	29	29	29
I=12	27	28	29	28	28	24	25	22	25	28	29	0	27	26	26	28	26	28	29	28
I=13	30	29	29	27	29	27	28	28	29	27	28	27	0	29	27	28	27	29	29	29
I=14	27	28	29	29	27	28	25	27	27	25	28	28	29	0	28	24	29	28	28	27
I=15	27	25	29	29	27	25	26	26	26	28	27	28	28	28	0	24	27	27	29	27
I=16	28	29	30	28	25	25	22	24	26	27	29	28	28	24	24	0	29	27	29	29
I=17	27	29	28	29	28	29	28	26	26	25	28	28	27	29	27	29	0	29	29	29
I=18	29	28	30	30	29	27	29	28	28	29	29	25	29	28	27	27	29	0	29	27
I=19	28	29	28	29	28	28	28	29	29	29	29	29	29	28	29	29	29	29	0	29
I=20	30	30	29	29	29	27	27	26	28	28	29	26	29	27	27	29	29	28	29	0

*Index numbers refer to operations listed in Table I, p. 28.

MATRIX OF PROPORTIONS*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.50	0.58	0.45	0.50	0.63	0.55	0.25	0.10	0.37	0.28	0.50	0.04	0.33	0.41	0.41	0.14	0.15	0.34	0.79	0.20
2	0.42	0.50	0.29	0.38	0.61	0.24	0.17	0.03	0.27	0.37	0.45	0.04	0.24	0.36	0.39	0.14	0.17	0.25	0.79	0.13
3	0.55	0.71	0.50	0.54	0.52	0.46	0.18	0.17	0.31	0.36	0.44	0.05	0.31	0.48	0.55	0.23	0.25	0.37	0.75	0.21
4	0.50	0.62	0.46	0.50	0.43	0.32	0.04	0.05	0.21	0.31	0.41	0.07	0.25	0.43	0.41	0.11	0.24	0.40	0.76	0.14
5	0.37	0.39	0.48	0.57	0.50	0.08	0.12	0.07	0.12	0.31	0.38	0.14	0.38	0.37	0.41	0.14	0.11	0.41	0.75	0.18
6	0.45	0.76	0.54	0.68	0.92	0.50	0.09	0.08	0.33	0.54	0.52	0.13	0.44	0.64	0.60	0.12	0.28	0.57	0.89	0.31
7	0.75	0.83	0.82	0.96	0.89	0.91	0.50	0.52	0.96	0.71	0.76	0.13	0.77	0.84	0.85	0.55	0.64	0.59	0.89	0.59
8	0.90	0.97	0.85	0.97	0.93	0.92	0.48	0.50	0.92	0.76	0.79	0.14	0.61	0.78	0.86	0.38	0.62	0.81	1.00	0.54
9	0.63	0.73	0.69	0.79	0.88	0.65	0.04	0.08	0.50	0.55	0.55	0.08	0.41	0.56	0.65	0.15	0.35	0.39	0.92	0.32
10	0.72	0.63	0.64	0.69	0.69	0.46	0.29	0.24	0.45	0.50	0.54	0.04	0.44	0.46	0.57	0.11	0.12	0.41	0.93	0.29
11	0.50	0.55	0.50	0.59	0.62	0.48	0.24	0.21	0.45	0.46	0.50	0.93	0.19	0.50	0.52	0.17	0.14	0.41	0.76	0.33
12	0.96	0.96	0.97	0.93	0.86	0.88	0.87	0.86	0.92	0.96	0.07	0.50	0.89	0.96	0.96	0.91	0.88	0.93	0.97	0.91
13	0.67	0.76	0.69	0.74	0.82	0.56	0.23	0.39	0.69	0.56	0.81	0.11	0.50	0.69	0.85	0.25	0.30	0.52	0.79	0.41
14	0.59	0.64	0.52	0.55	0.63	0.36	0.16	0.22	0.44	0.54	0.50	0.04	0.31	0.50	0.54	0.08	0.41	0.48	0.89	0.27
15	0.59	0.61	0.45	0.59	0.59	0.32	0.15	0.12	0.35	0.43	0.48	0.04	0.32	0.46	0.50	0.04	0.20	0.41	0.85	0.33
16	0.86	0.86	0.77	0.89	0.86	0.88	0.45	0.63	0.89	0.89	0.93	0.09	0.75	0.92	0.96	0.50	0.62	0.81	1.00	0.71
17	0.85	0.83	0.75	0.76	0.89	0.72	0.36	0.38	0.65	0.88	0.86	0.12	0.70	0.59	0.74	0.38	0.50	0.59	0.97	0.64
18	0.66	0.75	0.66	0.60	0.59	0.63	0.41	0.39	0.61	0.59	0.59	0.07	0.48	0.54	0.59	0.19	0.41	0.50	0.90	0.41
19	0.21	0.21	0.25	0.24	0.25	0.11	0.11	0.0	0.07	0.07	0.24	0.03	0.21	0.11	0.17	0.0	0.03	0.10	0.50	0.0
20	0.80	0.87	0.79	0.86	0.82	0.67	0.41	0.46	0.68	0.71	0.69	0.08	0.55	0.74	0.67	0.28	0.36	0.57	1.00	0.50
AVG	0.62	0.69	0.60	0.67	0.69	0.53	0.26	0.25	0.50	0.54	0.55	0.14	0.46	0.57	0.61	0.24	0.34	0.47	0.85	0.36

*Index numbers refer to operations listed in Table I, p. 28.

APPENDIX G

NUMBER OF RESPONDENTS TO EACH PAIR *

	J= 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
I= 1	0	13	11	11	10	14	12	15	13	13	12	17	13	22	22	23	14	21	23	22
I= 2	13	0	13	14	15	14	16	16	16	14	15	19	12	24	23	23	14	23	25	25
I= 3	11	13	0	10	13	15	14	14	15	12	12	18	13	24	23	23	14	20	22	22
I= 4	11	14	10	0	13	14	12	15	14	13	15	16	14	23	22	24	14	24	24	24
I= 5	10	15	13	13	0	13	10	12	13	17	16	16	16	21	21	20	17	21	22	22
I= 6	14	14	15	14	13	0	14	12	11	14	15	18	16	22	23	24	14	24	22	24
I= 7	12	16	14	12	10	14	0	10	15	16	14	16	15	20	20	21	15	22	22	22
I= 8	15	16	14	13	12	12	10	0	11	16	15	17	16	24	22	21	16	23	23	23
I= 9	13	16	15	14	13	11	13	11	0	15	16	17	17	24	23	24	18	22	24	23
I=10	13	14	12	13	17	14	16	16	15	0	12	20	13	23	25	24	16	24	25	21
I=11	12	13	12	13	16	15	14	15	16	12	0	19	10	21	24	23	16	23	23	23
I=12	17	19	18	18	16	18	18	17	17	20	19	0	19	18	16	17	15	18	19	19
I=13	13	12	13	14	16	16	16	16	17	13	10	19	0	24	22	23	16	23	23	23
I=14	22	24	24	23	21	22	20	24	24	23	21	16	24	0	13	13	21	16	16	14
I=15	22	23	23	22	21	23	20	22	23	25	24	16	22	13	0	12	23	16	13	15
I=16	23	23	23	24	20	24	21	21	24	24	23	17	25	13	12	0	21	14	16	17
I=17	14	14	14	14	17	19	15	18	18	16	16	15	16	21	23	21	0	23	23	21
I=18	21	23	20	24	21	24	22	23	22	24	23	18	23	13	16	14	23	0	16	15
I=19	23	25	22	24	22	22	22	23	24	25	23	16	23	13	13	16	23	16	0	16
I=20	22	25	22	24	22	24	22	23	23	21	23	19	23	19	15	17	21	15	16	0

*Index numbers refer to operations listed in Table I, p. 28.

MATRIX OF PROPORTIONS *

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.50	0.46	0.73	0.64	0.50	0.64	0.67	0.47	0.46	0.46	0.75	0.41	0.77	0.55	0.55	0.52	0.29	0.43	0.57	0.45
2	0.54	0.50	0.46	0.57	0.67	0.57	0.50	0.50	0.56	0.29	0.38	0.37	0.67	0.50	0.48	0.48	0.29	0.39	0.52	0.36
3	0.27	0.54	0.50	0.80	0.54	0.47	0.43	0.50	0.47	0.33	0.58	0.39	0.69	0.54	0.57	0.57	0.29	0.45	0.50	0.45
4	0.36	0.43	0.20	0.50	0.38	0.21	0.08	0.31	0.29	0.38	0.38	0.39	0.43	0.48	0.45	0.48	0.21	0.46	0.50	0.42
5	0.50	0.33	0.46	0.62	0.50	0.31	0.10	0.33	0.46	0.29	0.50	0.38	0.50	0.57	0.52	0.55	0.35	0.38	0.55	0.45
6	0.36	0.43	0.53	0.79	0.69	0.50	0.36	0.50	0.55	0.29	0.33	0.33	0.56	0.45	0.43	0.46	0.32	0.38	0.45	0.38
7	0.33	0.50	0.57	0.92	0.90	0.64	0.50	0.50	0.54	0.56	0.64	0.38	0.69	0.55	0.60	0.57	0.33	0.45	0.64	0.50
8	0.53	0.50	0.50	0.69	0.67	0.50	0.50	0.50	0.82	0.65	0.73	0.35	0.63	0.50	0.55	0.52	0.50	0.43	0.57	0.48
9	0.54	0.44	0.53	0.71	0.54	0.45	0.46	0.18	0.50	0.47	0.56	0.35	0.53	0.54	0.52	0.46	0.39	0.36	0.54	0.35
10	0.54	0.71	0.67	0.62	0.71	0.71	0.44	0.38	0.53	0.50	0.58	0.35	0.77	0.48	0.56	0.54	0.31	0.38	0.52	0.43
11	0.25	0.62	0.42	0.62	0.50	0.67	0.36	0.27	0.44	0.42	0.50	0.63	0.90	0.52	0.54	0.52	0.31	0.48	0.48	0.43
12	0.59	0.63	0.61	0.61	0.63	0.67	0.63	0.65	0.65	0.65	0.37	0.50	0.63	0.61	0.63	0.53	0.53	0.56	0.61	0.58
13	0.23	0.33	0.31	0.57	0.50	0.44	0.31	0.38	0.47	0.23	0.10	0.37	0.50	0.54	0.41	0.52	0.31	0.39	0.48	0.35
14	0.45	0.50	0.46	0.52	0.43	0.55	0.45	0.50	0.46	0.52	0.48	0.39	0.46	0.50	0.38	0.31	0.46	0.23	0.54	0.45
15	0.45	0.52	0.43	0.55	0.48	0.57	0.40	0.45	0.48	0.44	0.46	0.38	0.59	0.62	0.50	0.17	0.43	0.25	0.69	0.07
16	0.48	0.52	0.46	0.54	0.45	0.54	0.43	0.48	0.54	0.46	0.48	0.47	0.48	0.69	0.83	0.50	0.38	0.50	0.94	0.49
17	0.71	0.71	0.71	0.79	0.65	0.68	0.67	0.50	0.61	0.69	0.69	0.47	0.69	0.52	0.57	0.62	0.50	0.49	0.61	0.46
18	0.52	0.61	0.55	0.54	0.62	0.63	0.55	0.57	0.64	0.63	0.52	0.44	0.61	0.77	0.75	0.50	0.52	0.50	0.69	0.47
19	0.43	0.48	0.50	0.50	0.45	0.55	0.36	0.43	0.46	0.48	0.52	0.39	0.52	0.46	0.31	0.06	0.39	0.31	0.50	0.13
20	0.55	0.64	0.55	0.58	0.55	0.63	0.50	0.52	0.65	0.57	0.57	0.42	0.65	0.74	0.93	0.71	0.57	0.53	0.88	0.50
AVG	0.46	0.52	0.51	0.63	0.57	0.55	0.43	0.45	0.53	0.46	0.51	0.41	0.61	0.58	0.55	0.48	0.39	0.42	0.59	0.39

*Index numbers refer to operations listed in Table I, p. 28.